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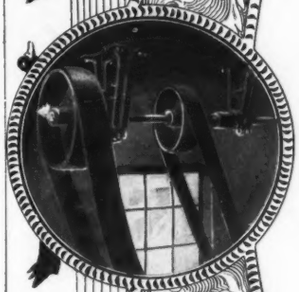

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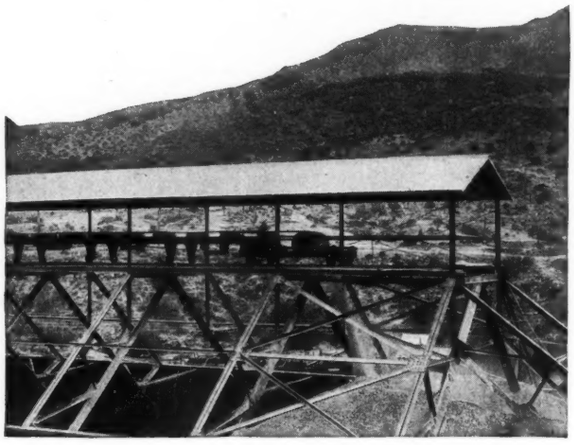

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Engineering and Mining Journal

VOLUME 101 JANUARY 8, 1916 NUMBER 2

Introduction

This is the annual review number of the year in which the *Engineering and Mining Journal* celebrates its 50th anniversary. A comparison of this issue, both in size and in character, with No. 1 of Vol. 1 shows picturesquely the marvelous development of the mining industry of the United States, which we have chronicled, reviewed and reflected without interruption during 50 years.

The production of the more important minerals and metals is summarized in the table on this page. The details appear on subsequent pages. It will be found that in some cases our contributors give figures that do not agree with our own. The explanation of such differences will generally be that the articles of outside contributors were necessarily written and put into type before our own statistics were available. The necessity of handling the great mass of material in this huge number in a few days leaves no time for leisurely comparison and revision to effect a careful coördination of all the data. We feel sure that no one, in the light of this explanation, will be misled by any discrepancies that may be discovered.

PRODUCTION OF METALS IN THE UNITED STATES

Metal	Unit	1913	1914	1915
Aluminum.....	Pounds	49,601,500	(*h*) 45,000,000	(*h*) 80,000,000
Copper (*a*).....	Pounds	1,225,735,834	1,158,581,876	1,424,640,565
Ferromanganese	Long tons	229,834	185,118	232,210
Gold (*b*).....	Dollars	88,884,400	94,531,800	98,891,100
Iron.....	Long tons	30,736,477	23,147,226	29,738,981
Lead (*c*).....	Short tons	433,476	538,735	565,356
Nickel (*e*).....	Pounds	47,124,330	30,067,064	38,966,138
Quicksilver.....	Flasks	(*h*) 20,000	16,300	(*f*) 20,681
Silver (*b*).....	Troy ounces	66,801,500	72,455,100	67,485,690
Zinc (*d*).....	Short tons	358,262	362,361	492,495

(*a*) Production from ore originating in the United States. (*b*) The statistics for 1913 and 1914 are the final and those for 1915 are the preliminary statistics reported jointly by the directors of the Mint and the U. S. Geological Survey. (*c*) Production of refined lead from ore and scrap originating in the United States: antimonial lead is included. (*d*) Total production of smelters, except those treating dross and junk exclusively; includes spelter derived from imported ore. (*e*) Imports; for 1915, first 9 months only. This nickel is refined in the United States for the production of metal, oxide and salts. (*f*) As reported by U. S. Geological Survey. (*g*) As reported by the Metallgesellschaft, Frankfurt am Main. (*h*) Estimated.

PRODUCTION OF MINERAL AND CHEMICAL SUBSTANCES

Substance	Unit	1913	1914	1915
Coal, anth. (*a*)..	Short tons	91,626,825	(*b*)90,821,507	89,000,000
Coal, bitu. (*a*)..	Short tons	478,688,867	(*b*)422,703,970	428,371,921
Coke (*a*).....	Short tons	45,953,808	(*b*)34,555,914	40,462,027
Copper sulphate.	Pounds	54,330,000	31,776,670	41,032,000
Iron ore.....	Long tons	61,847,116	42,911,897	58,843,804
Petroleum.....	Barrels	(*b*)248,446,239	(*b*)265,762,535	(*b*)267,400,000

(*a*) The coal and coke statistics are the estimates of "Coal Age." (*b*) As reported by U. S. Geological Survey.

In 1914 we were able to give at this time figures of the world's production of copper, gold, spelter and tin in the year that had closed a few days previously. These figures were not mere guesses, but were based on official reports covering 10 or 11 months of the year, with estimates only for November and December. When the final figures were published several months later, they were found to vary from our preliminary figures by only a trifling percentage. The statistics that we are able to present this year, as was also the case a year ago, are far more incomplete than in 1914 and previous years, thus reflecting the disturbances created by the war, which has put many commercial conditions out of joint.

American mining companies that publicly announce their dividends paid $75,383,387 in 1915, compared with $60,323,529 in 1914. Canadian and Mexican companies paid $10,686,384 in 1915 and $15,231,122 in 1914. United States metallurgical and holding companies connected with the mining industry paid $82,592,194 in 1915, as compared with $90,434,677 in 1914.

The production of spelter in the United States in 1915 was the largest on record. The output swelled enormously, quarter by quarter. If the December output could have been reported separately, it would have appeared that the rate of production at the end of 1915 was considerably in excess of the rate of the last quarter. The returns from the producers showed that the increase of production in 1915 was chiefly attributable to the older smelters (many of whom added new furnaces) and to concerns which repaired and restored to operation previously idle plants. The new plants, such as those at Kusa and Donora, contributed relatively little to the output of 1915, but by the end of the year they were going at pretty good gait, while several other new plants were about ready to come in.

We commend to our readers a careful reading of the remarkable series of reviews of technical progress that appears in this issue. Mr. Knopf writes of advances in the science of economic geology, Mr. Megraw of gold and silver metallurgy and progress in flotation, Professor Hofman of the metallurgy of lead, Mr. Addicks of the metallurgy of copper, Dr. Ricketts on the mining and metallurgy of copper, Mr. Ingalls of the metallurgy of zinc, and Mr. Cranston of gold dredging. All of these contributors are of national reputation as experts in their specialties; several of them are of international reputation. Such contributions as they offer in this issue are real enrichments of technical literature and are especially valuable to the general practitioner as expert summaries of what has been done in technical metallurgy.

To all the contributors who collaborated in this number we tender our thanks, and also to the many persons who have assisted in the collection of statistical information. Our thanks are due also to the producers of copper, lead, spelter and other substances, who have communicated to us the amount of their output in 1915 and have thereby enabled a close approximation to the actual production in 1915 to be made by Jan. 5, 1916, our date of going to press.

United States pig-iron production is estimated at 29,971,191 tons for the year. Production for the last half-year is estimated at 17,737,400 tons.

Gold production of the world is estimated at $470,979,890 for 1915, as against $451,582,129 in 1914.

Metal Markets

NEW YORK—Jan. 5, 1916

All of the principal metals advanced sharply in price during the last week, with the exception of spelter, which was a little softer in tone.

Copper, Tin Lead and Zinc

Copper—During the last two days of December some Connecticut manufacturers were large buyers at 22¼c., r. t., April delivery. Sales of copper for earlier delivery were made at 22½c. On Jan. 3 the market rose to 22½@23c., r. t., according to delivery, the difference between the prices for early and late deliveries becoming more pronounced. On Jan. 4 the market rose further to 23@23½c., r. t., numerous sales of round lots being made at those figures. Certain large producers were able to sell freely only for second-quarter delivery. Such first-quarter supplies as were free were furnished to regular customers at the same price. However, a buyer who wanted two million pounds had to be satisfied with one million. Sales in France were made at 24c., delivered there, which was reckoned equivalent to about 22.80@22.90c. here. In London the price rose to £112@114. The aggregate of the business transacted in this market was large, chiefly for second-quarter delivery. The freight congestion on the New Haven Ry. is causing a great deal of trouble among the copper manufacturers of the Naugatuck Valley, who are short of supplies, generally speaking.

Copper Sheets have been advanced and the base price is now 29c. per lb. for hot rolled and 30c. for cold rolled. Copper wire is 24@24½c. per lb. carload lots at mill.

Tin—Owing to the disturbance of traffic conditions in the Mediterranean, and the consequent scare respecting supplies, there was a sharp advance in this market, especially on Jan. 3, when business was done at 41½c. at the beginning of the day, and at 43c. at the close, the average price for the day being reckoned at 42½c. On Jan. 4 there was a further advance, 45c. being the high point. A large business was transacted during the week.

Lead—The A. S. & R. Co. advanced its price to 5.50c. on Dec. 31, and to 5.75c. on Jan. 4. A large business appears to have been done. Certain important producers are so well sold out that they can no longer figure prominently in the market.

Of the lead shipped by the Broken Hill Proprietary Co. in the first half of 1915, a total of 18,962 tons, 22.9% was delivered in Australia and New Zealand; 63.6% in China, Japan and India; 7.7% to Vladivostok, Siberia and 5.8% to Europe. The deliveries to Vladivostok are a new feature.

Spelter—Business in this metal was relatively small in volume, and was lighter in the second half of the week than in the first. There is an easier tone. Metal for prompt delivery is offered at 17c.; for February, at 16@16½c.; for March, at 15½@15¾c. First-quarter delivery is quoted at 16c. For second-quarter delivery, many producers are sellers at 14c., but buyers are not to be found.

Zinc Sheets have been advanced slightly and the base price is now 23c. per lb., f.o.b. Peru, Ill., less 8% discount. Business is active.

Other Metals

NEW YORK—Jan. 5

Aluminum—With a fair amount of business the market still shows an easier tendency. Quotations are 54@56c. per lb. for No. 1 ingots, New York.

Antimony—The market has been limited by the small amount offered, but has been active and closes strong. Ordinary brands, chiefly Chinese, are quoted at 42@42½c. per lb. The small stock of Cookson's available is held at 56c. per lb., New York.

Nickel—The market is steady and unchanged at 45@50c. per lb. for ordinary forms, according to size and terms of order. Electrolytic nickel is 5c. per lb. higher.

Quicksilver—Prices seem to have gone wild in the absence of new supplies, which have been very scarce. In New York $160 per flask of 75 lb. is named for large lots; $165@175 per flask for smaller orders. San Francisco price is $135@145, with small stocks. London price is £16 15s. per flask, with no discount from second hands.

Gold, Silver and Platinum

Gold coinage by the United States Mint in 1915 was especially large. Out of a total coinage for the calendar year amounting to $30,144,319.20, a total of $23,967,375 was gold. This included 1,500 octagonal $50, 1,500 round $50, 10,000 quarter eagles, and 25,000 gold dollars, coined for the Panama-Pacific Exposition, 719,550 double eagles, 410,075 eagles, 752,075 half eagles, and 606,100 quarter eagles. During the year the mints coined 60,000 special silver half dollars for the Panama-Pacific Exposition, and 2,912,850 half dollars, 7,878,450 quarter dollars, 6,580,450 dimes, 30,062,120 five-cent and 55,975,570 one-cent pieces.

Gold sales from the United States Assay office in New York in December were $3,230,572. For the year ended Dec. 31 the total sales were $60,616,224 in 1914, and $34,802,669 in 1915; a decrease of $25,313,555 last year.

Platinum—The situation is unchanged. Prices for the little that is to be had are nominal at $90@95 per oz. for refined platinum.

Silver—The holiday inactivity in silver has been succeeded by an inquiry sufficiently large to carry up the price to 26⅞d. in London today at which figure there is a moderate inquiry.

Italian Exports of metals and minerals, nine months ended Sept. 30, are reported as below, in metric tons:

	1913	1914	1915
Quicksilver	747	635	728
Graphite	6,264	6,118	5,610
Sulphur	283,283	229,941	241,478

DAILY PRICES OF METALS IN NEW YORK

Dec. Jan.	Sterling Exchange	Silver, Cts. per Oz.	Copper	Tin	Lead		Zinc
			Electrolytic, Cts. per Lb.	Spot, Cts. per Lb.	New York, Cts. per Lb.	St. Louis, Cts. per Lb.	St. Louis, Cts. per Lb.
30	4.7394	54⅞	22.00 @22.25	40½	5.40 @5.45	5.32½ @5.37½	15.25 @16.75
31	4.7363	55	22.25 @22.50	41	5.50	5.42½	15.25 @16.75
1	.....	...	.....	..	....	.....	.....
3	4.7338	55⅞	22.25 @22.75	42½	5.50	5.42½ @5.45	15.50 @16.50
4	4.7413	56½	22.75 @23.25	44¼	5.75	5.67½ @5.70	15.50 @16.50
5	4.7525	56½	22.75 @23.25	44½	5.75	5.67½ @5.70	15.50 @16.50

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

Dec.-Jan.	Silver	Copper				Tin		Lead		Zinc	
		Standard		Electrolytic							
		Spot	3 Mos.	£ per Ton	Cts. per Lb.	Spot	3 Mos.	£ per Ton	Cts. per Lb.	£ per Ton	Cts. per Lb
30	26 3/16	86⅜	86½	108	22.75	168	169	30¼	6.37	90	18.97
31	26¼	86⅛	86¼	108	22.75	168	169	30⅛	6 35	90	18.97
1	....	.....	.....	.....	.....	.....	....	.....	.....	....	....
3	26 11/16	86¾	86¾	110	23.18	171	172	30⅞	6.39	90	18.97
4	26¾	87⅛	87¼	111	23.39	174	175	31	6.53	90	18.99
5	26⅞	88¼	88	112	23.77	173⅞	174⅜	31¼	6.58	88	18.67

The above table gives the closing quotations on London Metal Exchange, All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices, in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £ 15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21½c.

Gold and Silver

By Frederick Hobart

The gold production of the world in 1915, according to the preliminary estimates presented in Table 1, showed an increase for the first time in three years. These estimates are largely based upon official returns covering 11 months, and in the instances where these are lacking, they are founded on the closest official figures obtainable, backed by information from engineers familiar with the conditions in the several countries. They are conservatively made, and it is believed that the final corrected figures will show some increase over those here given. That the gold-mining industry should make so excellent

TABLE 1. GOLD PRODUCTION OF THE WORLD

	1913	1914	1915
Transvaal	$181,889,012	$173,176,133	$188,397,707
Rhodesia	13,935,681	17,745,980	18,852,135
West Africa	7,846,560	8,671,371	8,556,550
Madagascar, etc	2,044,600	1,980,000	1,865,000
Total Africa	$205,715,653	$201,573,484	$217,671,392
United States	$88,884,400	$94,531,800	98,891,000
Mexico	20,500,000	18,185,000	16,975,000
Canada	16,216,131	15,925,044	15,875,000
Central America, etc	3,030,400	3,500,000	3,750,000
Total North America	$128,630,931	$132,141,844	$137,491,100
Russia, inc. Siberia	$29,500,000	$26,763,000	26,750,000
France	1,812,100	1,450,000	1,025,000
Other Europe	2,950,000	2,350,000	1,875,000
Total Europe	$34,262,100	$30,563,000	$29,650,000
British India	$12,176,783	$12,327,980	11,699,385
British and Dutch E. Indies	4,739,100	4,690,000	4,825,000
Japan and Chosen	7,394,300	7,476,500	7,850,000
China and others	3,658,900	3,625,000	3,675,000
Total Asia, not inc. Siberia	$27,969,083	$28,119,480	$28,049,385
South America	$13,058,400	$13,525,000	13,750,000
Australasia	53,033,391	45,659,271	44,368,013
Total for the world	$462,669,558	$451,582,129	$470,979,890

a showing in 1915 is not so remarkable when we consider that the European War has not directly affected any of the great gold-mining areas of the world. Even in Russia, which is one of the countries engaged in war, the gold-producing districts are mainly in the Urals and in Siberia, which are far from the scene of conflict.

The total gold production of the world, according to these figures, was $470,979,890, which is an increase of $19,397,761 over that of 1914 and of $8,310,332 over 1913. In the second table is shown the gold production of the world for 20 years past, the figures for the years prior to 1915 being the corrected reports of production.

TABLE 2. GOLD PRODUCTION OF THE WORLD FOR 20 YEARS

1896	$211,242,081	1906	$405,551,022
1897	237,833,984	1907	411,294,458
1898	287,327,833	1908	443,434,527
1899	311,505,947	1909	459,927,482
1900	258,829,703	1910	454,213,649
1901	260,877,429	1911	459,377,300
1902	298,812,493	1912	474,333,268
1903	329,475,401	1913	462,669,658
1904	349,088,293	1914	451,582,129
1905	378,411,054	1915	470,979,870

The gain in 1915 was due chiefly to the two leading producers, the Transvaal and the United States, the former showing an increase over 1914 of $15,221,574, while the United States had a larger production by $4,359,300. In the Transvaal the increase is explained by the closer working and the extension of operations, while in the United States the gain was well distributed over the various states and resulted chiefly from improvements in metallurgy and in methods of operation.

The four leaders among the gold-producing countries retained their respective rank and were, as for a number of years past, the Transvaal, the United States, Australasia and Russia. The Transvaal produced about 40% of the world's total and the United States about 21%, a little over 9% coming from Australasia and about 6% from Russia, so that these four countries furnished about three-quarters of the world's supply. The output of Australasia was somewhat less than in 1914, although the decrease was smaller than for several years past, amounting only to $3,291,258 against over $7,000,000 in 1914, as compared with the previous year. Most of the other countries do not show any material change.

Africa continues to be the chief source of the world's supply, the mines of that continent furnishing about 46% of the total. North America is second in rank, with about 28%. In Africa, especially in the Transvaal, there seems to be a practical contradiction of the pessismistic prophe-

TABLE 3. GOLD AND SILVER OUTPUT OF THE UNITED STATES*

(Gold in Values; Silver in Fine Ounces)

	Gold: Value		Silver: Fine Oz.	
	1914	1915	1914	1915
Alabama	$12,300	$5,100	300	.....
Alaska	16,547,200	16,626,700	865,900	838,100
Arizona	4,568,900	4,107,400	4,439,500	5,078,100
California	21,251,900	23,005,800	2,020,800	2,110,900
Colorado	19,902,400	22,191,200	8,804,400	7,395,100
Georgia	16,800	24,300	100	100
Idaho	1,187,200	1,048,600	12,573,800	10,595,300
Illinois	.....	.....	1,900	2,200
Maryland	200	400	100	100
Michigan	.....	.....	415,500	495,400
Missouri	.....	.....	60,000	56,400
Montana	4,143,600	4,763,100	12,536,700	12,690,200
Nevada	11,536,200	11,314,700	15,877,200	13,793,000
New Mexico	1,219,100	1,430,000	1,771,300	1,907,100
North Carolina	130,300	153,300	1,500	1,400
Oklahoma	.....	.....	6,200	.....
Oregon	1,589,400	1,739,400	147,400	126,500
South Carolina	3,200	2,100	.....	.....
South Dakota	7,334,000	7,397,400	179,800	195,400
Tennessee	6,400	8,400	102,800	141,000
Texas	8,800	2,800	574,700	720,400
Utah	3,377,000	3,494,800	11,722,000	11,168,500
Vermont	.....	.....	.....	100
Virginia	300	1,100	1,500	1,100
Washington	587,800	267,200	341,300	154,000
Wyoming	6,700	20,200	100	700
Continental United States	$93,4 9,700	$97,604,000	72,444,800	67,471,000
Porto Rico	2,800	100	.....	.....
Philippines	1,099,300	1,287,000	10,300	14,500
Totals	$94,531,800	$98,891,100	72,455,100	67,485,600

*As reported by the Director of the United States Mint and the United States Geological Survey.

cies of the approaching exhaustion of the auriferous deposits. There were, during 1915, no very important discoveries of new fields, such gains as were made coming chiefly from extended workings of well-known districts.

In North America some new placer fields were opened in Alaska, but did not add largely to the production of the year, although they may do so during 1916. The most reasonable expectations of increased gold production are based upon the possibilities in South America and perhaps, to a lesser extent, on probable discoveries in the Congo and elsewhere in Central Africa.

It is not possible to give, at this early date, any estimate approaching correctness of the silver production of the world. That of the United States showed a decrease of nearly 7%, the first loss reported in several years. In Mexico there was again a decrease, owing to the disturbed condition of the country and the interruption of mining operations. In Canada, also, there was a decrease, owing chiefly to the low price of silver that prevailed during a considerable part of the year, which induced the Cobalt producers to curtail their operations. Upon the whole we should assume the case of the United States as typical

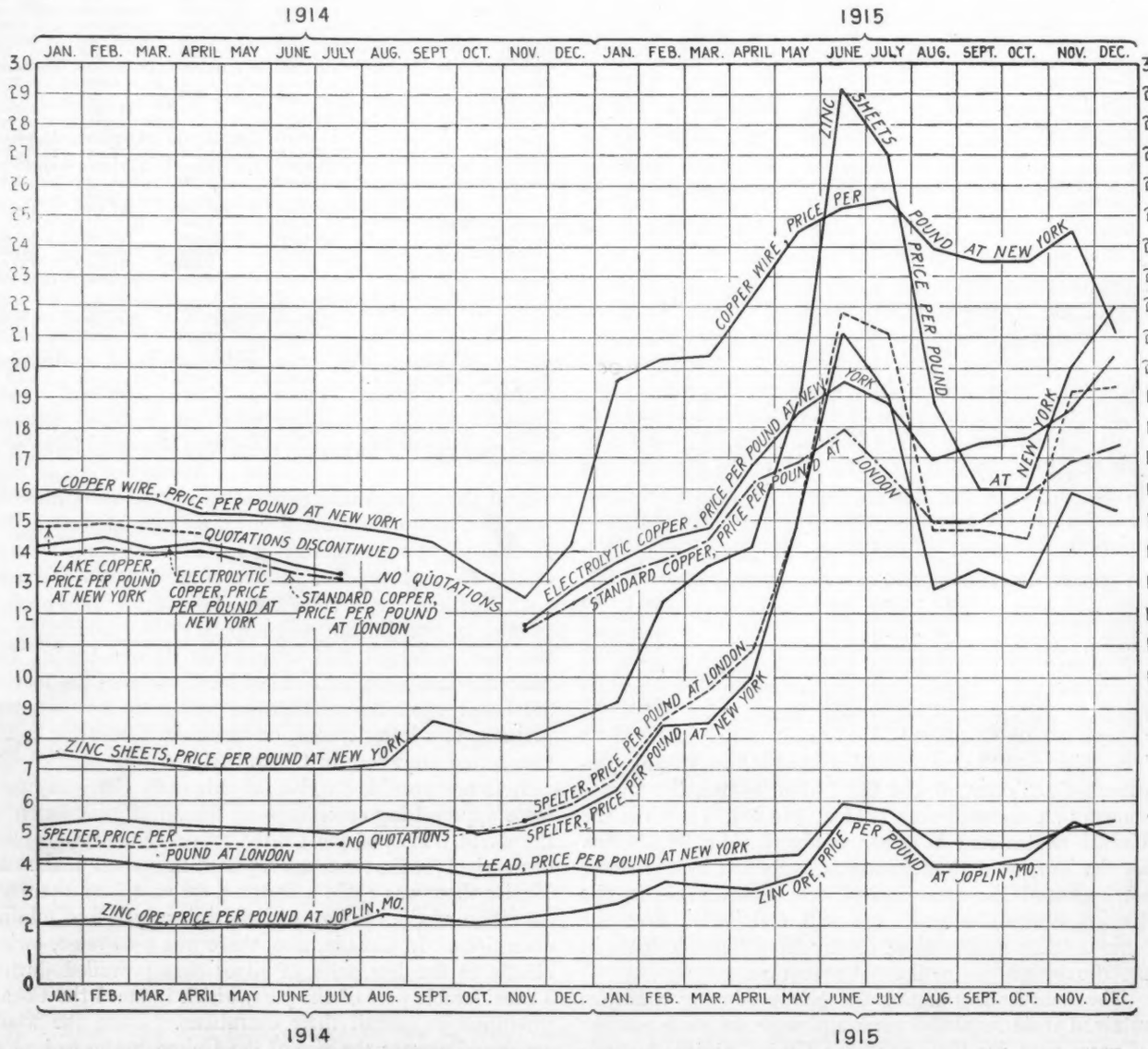
and estimate a reduction of from 7 to 10% in the silver output of the world.

Table 3 gives the gold and silver production of the United States for two years, the figures for 1915 being the preliminary statements made jointly by the United States Mint and the Geological Survey. These figures are based upon smelter production and upon the returns of the mints and assay offices, and in past years have proved to be very nearly correct, although rather conservative in their nature, the corrected figures being generally a little larger. According to this statement the gold production again showed an increase, the total being $98,891,800, which is $4,359,300 more than in 1914. The gain is widely distributed, the principal increases being in California and in Colorado, those in the former state resulting from extended dredging operations chiefly, while in Colorado they were principally the result of better mill work and improved methods. California maintained its position as the leading gold producer, with Colorado rather a close second, Alaska third and Nevada fourth. A second group of large producers, although some way behind the first four, were South Dakota, which is a gold producer only, Montana, Arizona and Utah, where the gold is won chiefly in connection with copper and other metals. These eight states produced in all 94% of the total, the remaining 6% being scattered among 16 states, the more important of which were Oregon, New Mexico and Idaho. Of our insular possessions, the Philippines showed an increase of about 25% over 1914, which was chiefly due to extended dredging operations, while the output of Porto Rico was trifling. It should be noted that the dredging work in the Philippines is largely under the direction of Australian and New Zealand capitalists and engineers, a fact which is

TABLE 4. MONTHLY AVERAGE PRICE OF SILVER

Month	New York			London		
	1913	1914	1915	1913	1914	1915
January	62.933	57.572	48.855	28.983	26.553	22.731
February	61.642	57.506	48.477	28.357	26.573	22.753
March	57.870	58.067	50.241	26.669	26.788	23.708
April	59.490	58.519	50.250	27.416	26.958	23.709
May	60.361	58.175	49.915	27.825	26.704	23.570
June	58.990	56.471	49.034	27.199	25.948	23.267
July	58.721	54.678	47.519	27.074	25.219	22.597
August	59.293	54.344	47.163	27.335	25.979	22.780
September	60.640	53.290	48.680	27.986	24.260	23.591
October	60.793	50.654	49.385	28.083	23.199	23.925
November	58.995	49.082	51.714	27.263	22.703	25.094
December	57.760	49.375	54.971	26.720	22.900	26.373
Year	59.791	54.811	49.684	27.576	25.313	23.675

New York quotations, cents per ounce troy, fine silver; London, pence per ounce sterling silver, 0.925 fine.


1914
1915
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT OCT. NOV. DEC.
COPPER WIRE, PRICE PER POUND AT NEW YORK
QUOTATIONS DISCONTINUED
LAKE COPPER, PRICE PER POUND AT NEW YORK
ELECTROLYTIC COPPER, PRICE PER POUND AT NEW YORK
STANDARD COPPER, PRICE PER POUND AT LONDON
NO QUOTATIONS
ELECTROLYTIC COPPER, PRICE PER POUND AT NEW YORK
STANDARD COPPER, PRICE PER POUND AT LONDON
ZINC SHEETS, PRICE PER POUND AT NEW YORK
SPELTER, PRICE PER POUND AT LONDON
SPELTER, PRICE PER POUND AT NEW YORK
SPELTER, PRICE PER POUND AT LONDON
NO QUOTATIONS
LEAD, PRICE PER POUND AT NEW YORK
ZINC ORE, PRICE PER POUND AT JOPLIN, MO.
ZINC ORE, PRICE PER POUND AT JOPLIN, MO.

METAL PRICES IN 1914 AND 1915, MONTHLY AVERAGES

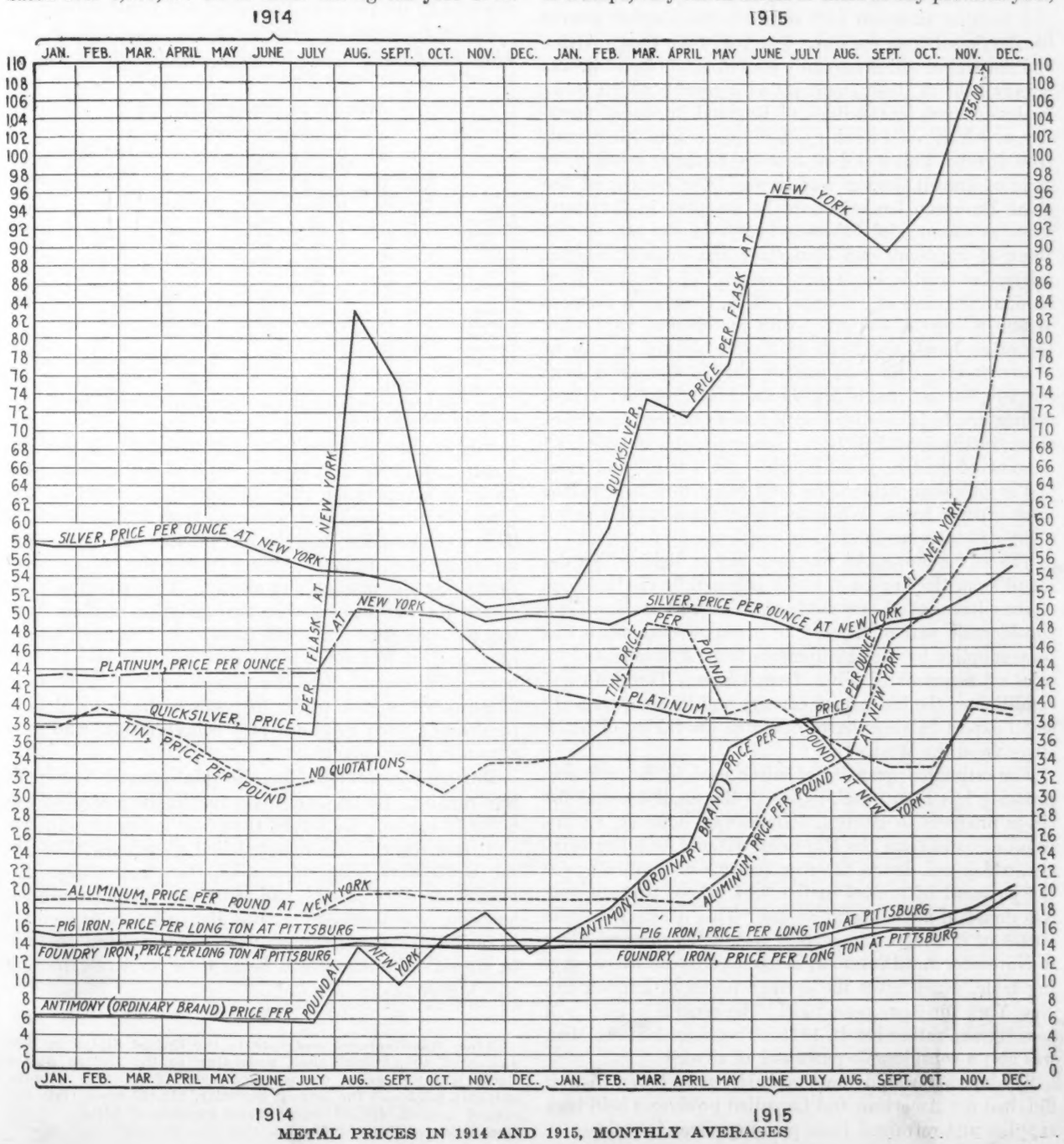
accounted for by the proximity of Australia to the Islands and the large degree of ignorance as to their resources, which still prevails at home.

The total silver production of the United States in 1915 was 67,485,600 fine ounces, a decrease of 4,969,500 ounces from 1914. As is well known, the silver output of the United States is made chiefly in connection with other metals, largely copper, lead and gold, comparatively little being produced from mines whose chief value is in silver. The greatest losses in silver were in Idaho and Nevada, the other large silver-producing states very nearly holding their own. The four leading silver producers, in the order of their importance were Nevada, Montana, Utah and Idaho. A second group, some way behind the first, comprised Colorado, Arizona, California and New Mexico. No other state than the eight mentioned produced over 1,000,000 oz. of silver during the year 1915.

Commercial Movement of the Precious Metals

While the European War had little effect on the mining of gold, it had an important influence on the commercial movement of the metal. This was entirely different from what we are accustomed to seeing in normal times. The demand for gold everywhere has been great, and it is probable that an unusually large portion of the gold mined passed into currency either as coin or in bullion used in bank reserves and in the making of exchanges. Certainly a comparatively small amount was employed in the arts, the efforts of European countries being to retain as much as possible in their own hands.

The United States has been the chief beneficiary of the gold production of the year. The extent of our exports to Europe, very far in excess of those of any previous year,


1914
1915
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
SILVER, PRICE PER OUNCE AT NEW YORK
PLATINUM, PRICE PER OUNCE
QUICKSILVER, PRICE PER FLASK AT NEW YORK
TIN, PRICE PER POUND
NO QUOTATIONS
ALUMINUM, PRICE PER POUND AT NEW YORK
PIG IRON, PRICE PER LONG TON AT PITTSBURG
FOUNDRY IRON, PRICE PER LONG TON AT PITTSBURG
ANTIMONY (ORDINARY BRAND) PRICE PER POUND AT NEW YORK
135.00

METAL PRICES IN 1914 AND 1915, MONTHLY AVERAGES

was strikingly illustrated, especially in the latter half of the year, by the depression in exchange and by the very large amount of loans made to foreign countries. Of these, the most important was the advance of $500,000,000 to the Allied nations, but there were a number of individual loans made to various countries which we have not room to specify in detail, but which brought the total amount up to more than $900,000,000. These advances were supplemented by the return or resale to us of American securities held abroad, the total of which it is impossible to estimate. Besides all this the imports of gold into this country exceeded the exports for the year by about $414,550,000. Adding to this our own gold production of $98,891,000, it will be seen that practically the United States absorbed in 1915 not only the entire gold production of the year, but over $40,000,000 additional and is therefore at present the chief gold-holding nation of the world.

A peculiar situation with regard to the English reserve has developed from the war. The gold from South Africa and Australia, which normally goes direct to London, was largely held in those countries as a reserve which could be drawn upon by the Bank of England in case of necessity, or which could be shipped, if required, to other countries direct. This was done to avoid as far as possible the risks of transit during war times. The returns of the great European banks cannot be accepted in the usual sense as commercial balances, except in the case of the Bank of England, and even there the colonial reserves referred to must be taken into account. The Bank of England, at the close of December, 1915, reported a decrease of $90,085,000 as compared with the close of 1914. On the other hand, the Bank of France showed a gain of $150,000,000 in its gold reserve, that of Germany about $90,000,000 and that of Russia about $30,000,000. These figures are to be accepted with reserve, since the aim of these institutions has been to accumulate as great an amount of gold as possible, while the currency of most of the European nations has been going to a large extent upon a paper basis. What the future result of this movement will be is an interesting problem.

The silver movement has been rather light. The demand from the Far East, which is generally the backbone of the silver market, has not been as large as usual, while a considerable part of the Indian market requirements has been supplied by direct shipments from Australia and by sales of accumulated silver from China. The disturbed condition of the last-named country and its comparatively small export balances have prevented the taking of much silver from the West.

The estimated quantity of silver used in the arts was probably less than usual, owing to the small demand for silver products in Europe. There was, however, an unusual demand from the European nations for silver coinage, which was due to the requirements of such coins for the payment of armies in the field, where paper money was doubtful and difficult of use. This demand was the means of causing an important rise in the price of silver in November and December, as is shown in the accompanying table, which gives the average prices in London and New York for three years past. The general level, it will be seen, was rather low in 1915. The United States Mint was also a considerable purchaser of silver.

The market would have probably gone lower than it did, had not American and Canadian producers held back supplies and refrained from pressing silver for sale.

Platinum

At the beginning of 1915 the platinum market at New York was quiet at $41@42 per oz. for refined. During the first quarter there was but little change, though prices were easier if anything, some business being reported as low as $38. On the other hand, there was improvement in the market for crude platinum at Ekaterinburg. The Russian government stopped the export of platinum. At a conference of gold and platinum producers in Petrograd it was reported that the smaller producers had ceased working. The stock of platinum was large, but generally it was in strong hands. In April the Russian government permitted resumption of exports, but imposed special conditions. However, there was no difficulty in securing permits for exportation to friendly countries. About May 1 it was reported that 46,000 oz. of crude platinum was held by the banks in Petrograd and Ekaterinburg.

At the mid-year the price for refined platinum at New York was $37@39 per oz. About the middle of August an upward tendency began to be exhibited, the first change in the quotation being to $39½@41. It was not, however, until the first week of September that consumers awoke to a realization that the market was short of supplies. In that week the price rose from $42 to $48@50. This was about the season when manufacturing jewelers are accustomed to buy largely. During the remainder of September the market was uneasy. This situation continued into November, when the quotation at New York was $52@56 per oz. In the meanwhile there had been a crazy market in Russia, where platinum had been bought largely for export, wherefor it was as good a medium of exchange as gold, while there was an increased domestic demand from sulphuric-acid concentrators, who were expanding their plants.

During November the price for platinum at New York rose rapidly. By the end of the month the quotation was $70@74 per oz. In Russia there was a similar advance, and from there it was reported that abandoned mines in the Urals were being reopened. During December the market was very excited, and at the end of the month the quotation was about $90 per oz. Refiners were disinclined to quote except to their regular customers, and supplies in Russia were being held back, their holders expecting still higher prices.

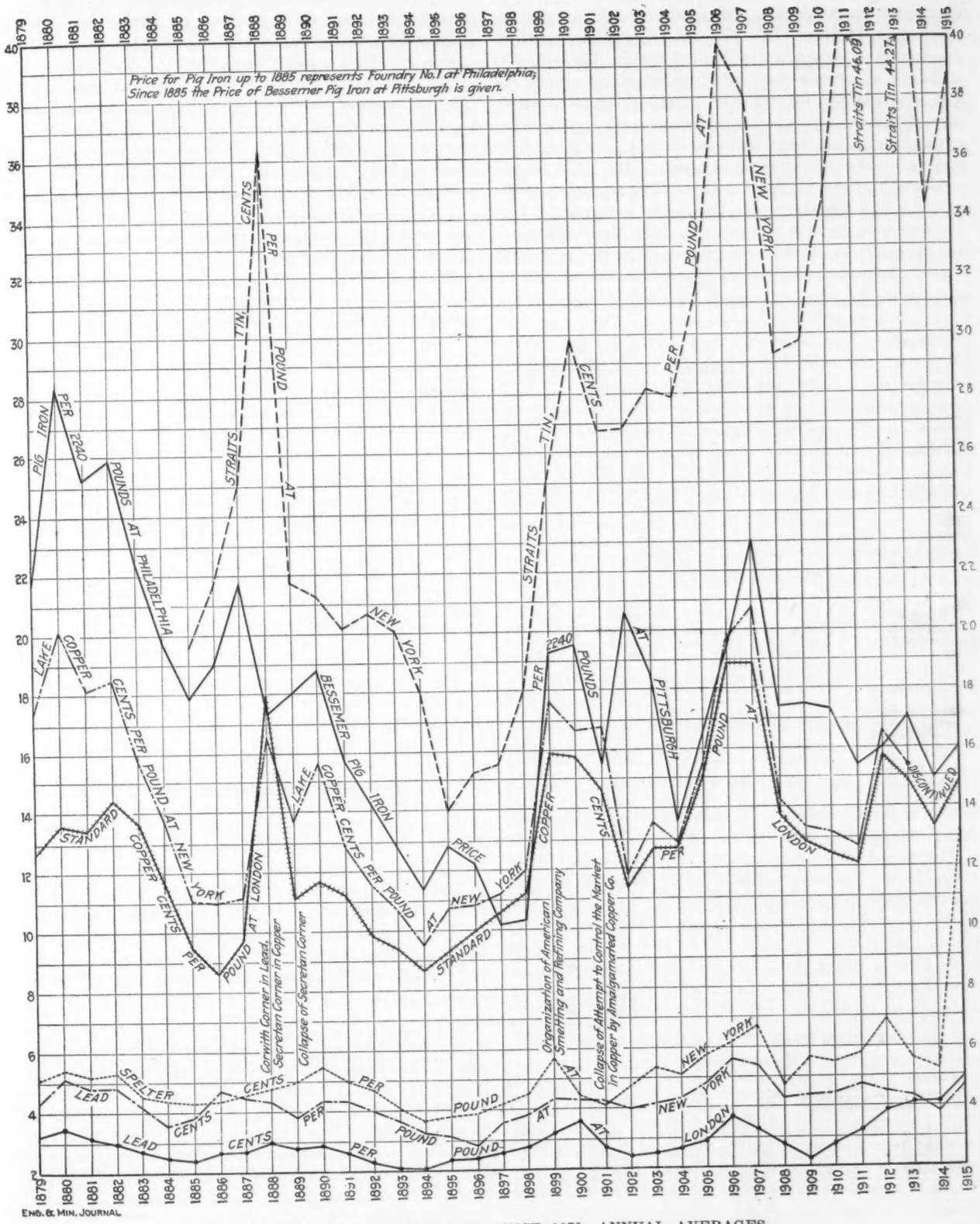
AVERAGE PRICES OF PLATINUM

(In Dollars per Ounce Troy)

	1914			1915		
	New York Refined Platinum	Russia, Crude Metal 83% Platinum St. Petersburg	Russia, Crude Metal 83% Platinum Ekaterinburg	New York Refined Platinum	Russia, Crude Metal 83% Platinum St. Petersburg	Russia, Crude Metal 83% Platinum Ekaterinburg
January	43.38	36.43	36.28	41.10	.....	.....
February	43.50	36.36	36.28	40.00	30.38	30.08
March	43.50	36.39	36.28	39.50	30.38	30.08
April	43.50	36.46	36.28	38.63	30.38	30.08
May	43.50	36.41	36.28	38.50	30.57	30.08
June	43.50	36.09	36.00	38.00	32.39	31.02
July	43.50	35.72	35.72	38.00	32.39	31.02
August	50.20	.....	.....	39.25	32.30	30.73
September	50.00	.....	35.72	50.00	.....	.....
October	49.50	.....	33.84	54.50	37.98	38.70
November	45.45	.....	.....	62.63	47.45	46.64
December	42.19	.....	.....	85.50	56.40	56.25
Year	45.14	.....	.....	47.13	.....	.....

New York average for year 1913, $44.88; 1912, $45.55; 1911, $43.12; 1910, $32.70 per ounce Troy.

Lime Manufactured and Sold in the United States in 1914 amounted to 3,380,928 tons, according to the United States Geological Survey, a decrease of 5.96% from 1913. Pennsylvania produced the largest quantity, 852,927 tons; Ohio the second largest, 487,693 tons. Total number of kilns is 2,374. The hydrated-lime production was 515,121 tons.


Price for Pig Iron up to 1885 represents Foundry No. I at Philadelphia; Since 1885 the Price of Bessemer Pig Iron at Pittsburgh is given.
PIG IRON PER 2240 POUNDS AT PHILADELPHIA
LAKE COPPER CENTS PER POUND AT NEW YORK
STANDARD COPPER CENTS PER POUND AT LONDON
STRAITS TIN CENTS PER POUND AT NEW YORK
BESSEMER PIG IRON PRICE AT PITTSBURGH
LAKE COPPER CENTS PER POUND AT NEW YORK
STANDARD COPPER CENTS PER POUND AT LONDON
STRAITS TIN CENTS PER POUND AT NEW YORK
Straits Tin 46.09
Straits Tin 44.27
DISCONTINUED
SPELTER CENTS PER POUND AT NEW YORK
LEAD CENTS PER POUND AT NEW YORK
LEAD CENTS PER POUND AT LONDON
Corwith Corner in Lead.
Secretan Corner in Copper
Collapse of Secretan Corner
Organization of American Smelting and Refining Company
Collapse of Attempt to Control the Market in Copper by Amalgamated Copper Co.
ENG. & MIN. JOURNAL

COURSE OF METAL PRICES SINCE 1879—ANNUAL AVERAGES

Copper

The situation of copper at the end of 1915 may be diagnosed approximately from the figures in the accompanying tables. The first table gives the smelters' production of copper in the United States, this being the summary of reports received from all of the producers. The distribution by state of origin is approximately correct, but those figures are subject to more revision than is the grand total, for the reason that it is impossible to make a precise allocation at this early date. The copper production of the United States in 1915 was larger than in 1914. In the later year the mines were operated at reduced rates for five months. In 1915 the curtailment was generally in effect during the first quarter only, and during the remainder of the year all of the companies strove to force production to the utmost. In so doing, American refining capacity was taxed to the maximum.

SMELTERS' PRODUCTION OF COPPER IN THE UNITED STATES

(In Pounds)

State	1912	1913	1914	1915
Alaska	32,602,000	24,452,000	24,288,000	64,600,000
Arizona	357,952,962	399,849,745	387,978,852	443,094,331
California	31,069,029	32,390,272	29,515,488	38,343,927
Colorado	7,502,000	7,670,090	10,104,579	6,920,000
Idaho	5,964,542	8,434,028	4,856,460	5,720,000
Michigan	231,628,486	159,437,262	157,089,795	241,951,921
Montana	309,247,735	285,336,153	243,139,737	265,779,643
Nevada	82,530,608	84,683,961	60,078,095	65,598,475
New Mexico	27,488,912	46,953,414	64,338,892	67,827,730
Utah	131,673,803	147,591,955	153,555,902	188,080,000
Washington	1,121,109	448,805	165,023	*
East and South	18,592,655	24,333,014	19,213,965	20,900,143
Other States	4,396,667	4,155,135	4,257,088	†15,824,395
Totals	1,241,770,508	1,225,735,834	1,158,581,876	1,424,646,565

*Included in "Other States." †Included in this figure is a good deal of copper that could not be distributed as to origin at this time.

SMELTERS' PRODUCTION

(In Pounds)

Source	1912	1913	1914	1915
N. American ore	1,489,176,562	1,438,565,881	1,327,488,479	1,616,499,571
Foreign ore	53,701,307	55,803,202	50,101,308	44,538,207
Scrap	11,949,348	22,427,889	20,894,559	15,275,991
Totals	1,554,827,217	1,516,796,972	1,398,484,346	1,676,313,769
To foreign refiners	45,735,673	36,682,605	36,765,920	40,062,900
To American refiners	1,509,091,544	1,480,114,367	1,361,718,426	1,636,250,869
Crude copper imported	144,480,144	169,315,869	131,125,076	140,000,000
Total crude copper	1,653,471,688	1,649,430,236	1,492,843,502	1,776,250,869

The second table gives the total supply of crude copper available to American refiners. The third table summarizes the world's production of copper in 1915. These figures are offered with considerable diffidence, for the reason that it was impossible to obtain the usual reports from Europe and Africa. Cable advices from London on Jan. 3 were to the effect that copper-production figures were quite impossible, but it was expected that the principal countries would show marked decreases. A report from our correspondent in Petrograd indicates a large increase in the Russian production, owing to the mines of the Caucasus being in the war zone. The returns from the United States, Mexico, Canada, Cuba, Australia, Peru, Chile and Japan are approximately complete. They show a further diminution in the production of Mexico, which in 1915 dwindled almost to insignificance. Japan and Chile, on the other hand, showed increases, operations among the Japanese mines having been forced, while the production of Chile was swelled by the growing output of Braden and the new output of Chuquicamata.

WORLD'S PRODUCTION OF COPPER (*)

(In Metric Tons)

Country	1912	1913	1914	1915
United States	563,260	555,990	525,529	646,212
Mexico	73,617	58,323	36,337	30,969
Canada	34,213	34,880	34,027	47,202
Cuba	4,393	3,381	6,251	8,836
Australasia	†47,772	†47,325	37,592†	32,512
Peru	26,483	25,487	23,647	††32,410
Chile	39,204	39,434	40,876	47,142
Bolivia	4,681	3,658†	1,306†	**3,000
Japan	62,486*	73,152†	72,933§	§75,000
Russia	33,550‡	34,310‡	31,933†	**16,000
Germany	24,303†	25,308†	30,480†	**35,000
Africa	16,632†	22,870†	24,135†	**27,000
Spain and Portugal	59,873†	54,696†	37,099†	**35,000
Other countries	29,555†	27,153†	25,176†	**25,000
Totals	1,020,022	1,005,978	923,888	1,061,283

* The statistics in this table are our own compilations, except where specially noted to the contrary. † As reported by Henry R. Merton & Co. ‡ As officially reported. § Privately communicated to us from Japan. **Estimated. ††Communicated by L. Vogelstein & Co.

The exports of copper from the United States in October and in the 10 months ended Oct. 31, as reported by the Department of Commerce, in pounds, were:

	October	Ten Months
Ore, matte, etc., contents	264,685	1,901,841
Unrefined, blister, etc.	.....	202,239
Ingots, bars, etc.	44,141,216	452,906,953
Plates and sheets	537,033	23,285,236
Wire	1,946,426	44,067,775
Old and scrap	.....	6,664,050
Total	46,889,360	529,028,097

In addition manufactures of copper, weight not given, were exported, valued at $5,773,916 for the ten months.

The imports of copper for October and for the 10 months ended Oct. 31 are reported as follows, in pounds:

	October	Ten Months
Ore, matte, etc., contents	9,339,386	97,570,156
Unrefined, blister copper, etc.	18,741,150	74,856,217
Bars, plates, etc.	2,003,554	78,471,894
Old and miscellaneous	599,406	5,959,355
Total	30,683,496	256,857,624

The actual tonnage of ore, concentrates and matte, of which the contents are given, was 40,570 tons in October and 351,178 tons in the 10 months.

Copper Market in 1915*

January—The year opened with copper at about 12.70c. Improvement in the demand manifested itself almost immediately, and the price rose steadily, the quotation at the end of the month being 14.40@14.50c. There were some mysterious features in the market, which later in the year turned out to be connected with a huge speculative operation.

February—With the beginning of this month there was a lull in buying. The large producers made no effort to

*On any given day copper is apt to be sold at a range of price even when the market is stationary, such range exhibiting the competition among sellers and the shopping among buyers; also there are differences in price according to conditions of sale. In periods of activity there are, moreover, changes in price between the beginning and end of a day. In quoting figures in this annual review we have reference to what we have in our weekly market reports during the year computed as the daily average price. Quotations are reduced to terms of net cash, New York. Copper for domestic delivery is commonly sold on "regular terms." "Regular terms" in the sale of copper mean that the seller delivers the copper to the buyer, paying the freight on it, and allows him 30 days after his receipt of the copper in which to make payment, or if he chooses to pay cash, the bill is discounted at the rate of ½%. To arrive at the difference between a sale upon these terms and a cash sale f.o.b. refinery, which is regarded as being f.o.b. New York, the interest on the value of the copper while in transit is commonly reckoned. This is a matter of 10 days. When copper sells at 18¼c., regular terms, the equivalent net price is therefore about 18.03c., there being 0.09125c. discount, 0.1c. freight and 0.0304c. loss of interest, a total of 0.22c. The freight rate is naturally a variable, being less to some nearby factories and more to some of the more remote ones. About 10c. per 100 lb. is regarded as being an average transportation cost.

solicit additional business, being well satisfied with the large sales effected during the previous three months, but dealers anxious to do business all the time immediately began to quote the market down, seeking the level at which copper could be turned over. After a decline to about 14.15c., there was a rally to 14.35@14.55c., where the month closed. During February the market was rather confused.

March—Improvement early manifested itself, and the price had a rising tendency right through the month. At the end the quotation was 15.50@15.60c. The disturbance of conditions respecting the transaction of foreign business began to attract much attention. On Mar. 17 it was written "with respect to sales for export there are all kinds of uncertainties as to exchange, insurance and freight, and even of freight room at all, and a shipper can seldom figure out what he is going to realize until the business is completed." Also it was noted in March that the demand for copper, both foreign and domestic, was attributable to military requirements rather than to peaceful.

April—Market reports began to talk about improvement in domestic consumption, especially among the sheet rollers and wire drawers, but the improvement was char-

MONTHLY AVERAGE PRICE OF COPPER

	New York Electrolytic				London Standard			
Month	1912	1913	1914	1915	1912	1913	1914	1915
Jan....	14.094	16.488	14.223	13.641	62.760	71.741	64.304	60.756
Feb....	14.084	14.971	14.491	14.394	62.893	65.519	65.259	63.494
Mar...	14.698	14.713	14.131	14.787	65.884	65.329	64.276	66.152
Apr....	15.741	15.291	14.211	16.811	70.294	68.111	64.747	75.096
May...	16.031	15.436	13.996	18.506	72.352	68.807	63.182	77.600
June...	17.234	14.672	13.603	19.477	78.259	67.140	61.336	82.574
July...	17.190	14.190	13.223.	18.796	76.636	64.166	60.540	76.011
Aug....	17.498	15.400	*	16.941	78.670	69.200	*	68.673
Sept...	17.508	16.328	*	17.502	78.762	73.125	*	68.915
Oct....	17.314	16.337	*	17.686	76.389	73.383	*	72.601
Nov....	17.326	15.182	11.739	18.627	76.890	68.275	53.227	77.744
Dec....	17.376	14.224	12.801	20.133	75.516	65.223	56.841	80.773
Year...	16.341	15.269	.....	17.275	72.942	68.335	.....	72.532

New York, cents per pound. London, pounds sterling per long ton of standard copper. * No quotations.

acterized as "spotty." The brass makers were already very busy with war orders. In the second week of April the market rose sharply upon fairly large transactions. Fancy prices began to be realized on special brands of Lake copper. As the month wore on, large buying developed, and at the end of the month the quotation was 18.70@18.80c.

May—With the opening of this month there was a lull again and a shading of prices in some quarters. During the second half the price declined to about 18.30c. At this time the Calumet & Hecla company was reported to be well sold ahead at 23c. per lb., and domestic consumers who previously had never used anything but Lake copper were said to be considering the use of electrolytic. Toward the end of May the market rallied, and the month closed at 18.50@18.60c.

June—About June 4 an active demand began to develop with buying of such magnitude as to start a sharp advance in the price. At the middle of the month an average of 20c., net cash, was realized. The volume of business consummated was stupendous. It was reported at this time that the Anaconda company had sold 10% of its expected output in 1916 at prices in the neighborhood of 20c. The great buying movement having spent itself, the market relapsed to 19.45@19.75c. at the end of the month. Noteworthy features at the mid-year were the unusual disparity between the prices for electrolytic and casting copper—about 1c. per lb.—that still prevailed. Prices for electrolytic copper and standard in the London market had been entirely out of joint for a long time, for the reason that there was no longer a free market for standard, inasmuch as no copper could be exported from England. Foreign refiners were therefore unable to buy warrants and accept delivery of the copper for shipment to their refineries.

July—During the first half the market was dull, but there was no great change in price. During the second half there was more pressure to sell, and the price had declined to 17.35@17.55c. by the end of the month. The British government decided to release raw copper for export with certain stipulations and guarantees, and some of such copper was bought by American refiners, but the extraordinary differential between refined and standard continued throughout 1915.

August—This was another dull month. About the middle the market became weak and business was done at 15.75@15.85c. This relatively low price attracted buyers who really were in need of copper, and their demand put the market up to 17.35@17.85c. by the end of the month, but sellers were injudicious, advancing prices too rapidly, and buyers were frightened away. Stocks at refineries were reported as not increasing to any great extent, owing to the large deliveries still being made on old orders, but production was proceeding at a high rate—one estimate being 160,000,000 lb. per month—and this caused some concern. There was even some gossip among the producers about taking steps to curtail the output.

September—An improved sentiment among the principal sellers of copper was discernible. Certain houses that previously had been rather bearish began to be more

AVERAGE MONTHLY PRICES OF COPPER MANUFACTURES

(In Cents per Pound)

	1913		1914		1915	
	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper
January....	19.09	23.50	15.94	20.75	14.80	19.50
February...	16.38	22.50	15.88	20.50	15.19	20.25
March.....	16.39	21.50	15.60	20.35	16.09	20.63
April.....	16.50	21.50	15.25	20.25	18.03	22.38
May.....	16.50	21.50	15.23	19.90	19.95	24.50
June.....	16.18	21.10	15.03	19.56	21.13	25.25
July.....	15.88	20.50	14.88	19.38	21.63	25.50
August.....	16.60	21.50	14.63	18.80	19.25	23.90
September..	17.84	22.50	14.34	18.00	19.34	23.50
October.....	17.75	22.50	13.34	17.38	19.28	23.50
November..	17.28	21.15	12.50	17.50	19.84	24.44
December..	15.79	20.50	14.25	18.88	21.81	26.00
Year.....	16.85	21.69	14.74	19.24	19.21	22.93

optimistic. However, for several weeks the market continued to be dull and disappointing. Domestic consumers appeared to be acting in concert in staying out of the market, a feature of their policy that was becoming increasingly prominent. The matter of freight rates and freight space for shipments to Europe caused a good deal of concern among shippers. The rate on copper to European ports at this time was about 30 to 40c. per 100 lb. Toward the end of the month there was some improvement in demand. On September 30 the quotation was 17.80@18c.

October—The Lake producers, who had realized 23c. per lb. in May and June, had remained out of the market for several months, hoping to be able to sell their product once more at a premium. Disappointed in this, they reëntered the market and tried to sell in competition with electrolytic copper, but did not find this easy. During the time when Lake was so scarce, the producers of electrolytic took some trouble to find a foothold for their product in quarters where previously it had not been used. When the Lake producers tried to get back their old customers, they were told in some cases that electrolytic was liked

better. By the middle of October the price for copper had declined to about 17.50@17.60c. Then there was another improvement, which turned out to be the forerunner of a great demand, and at the end of October the quotation was 17.70@17.80c. During October the copper market was in a rather chaotic condition. Certain producers who were fortunate in having large stocks of copper abroad made excellent sales out of warehouse there, and being satisfied with that business, made no effort to do anything here. Other producers, in selling for export, found it difficult to arrange for freights, and taking chances on freight rates and exchange, their probable net return was a good deal a matter of guesswork. Some producers were disposed to take business whenever and however they could get it. The competition of the Lake producers was sharp.

November—The strike at the Nichols refinery, early in this month, started something of a scare among buyers. On Nov. 15 the advance began to be rather violent. It continued without interruption right up to the end of the month, when the quotation was 19.50@19.75c. The volume of business consummated in November was huge, being but little less than that done in June.

December—With the opening of this month the market became more quiet, the price settling to a basis of about 19½c., net cash, New York. The matter of freight rates to Europe became even more troublesome, contracts at $1 per 100 lb. being made early in the month and at $1.50 toward the end. About the middle of December domestic manufacturers, especially some of those who had ammunition contracts, began to exhibit signs of nervousness. These manufacturers had failed to contract for all the metal that they needed for their own products already sold. When they attempted to cover their shorts, they found that copper was not easy to get and that they had to bid for it. On Dec. 22 was announced the consummation of a transaction whereby the British government purchased 60,000 long tons of copper from the two leading producing interests, for delivery during 1916, the price being in the neighborhood of 20c., New York. The news of this and the realization that but little unsold copper was available until after the first quarter of 1916 excited the market. At the end of the month the price was 22¼c., net cash, New York.

Copper and Zinc Production in Montana

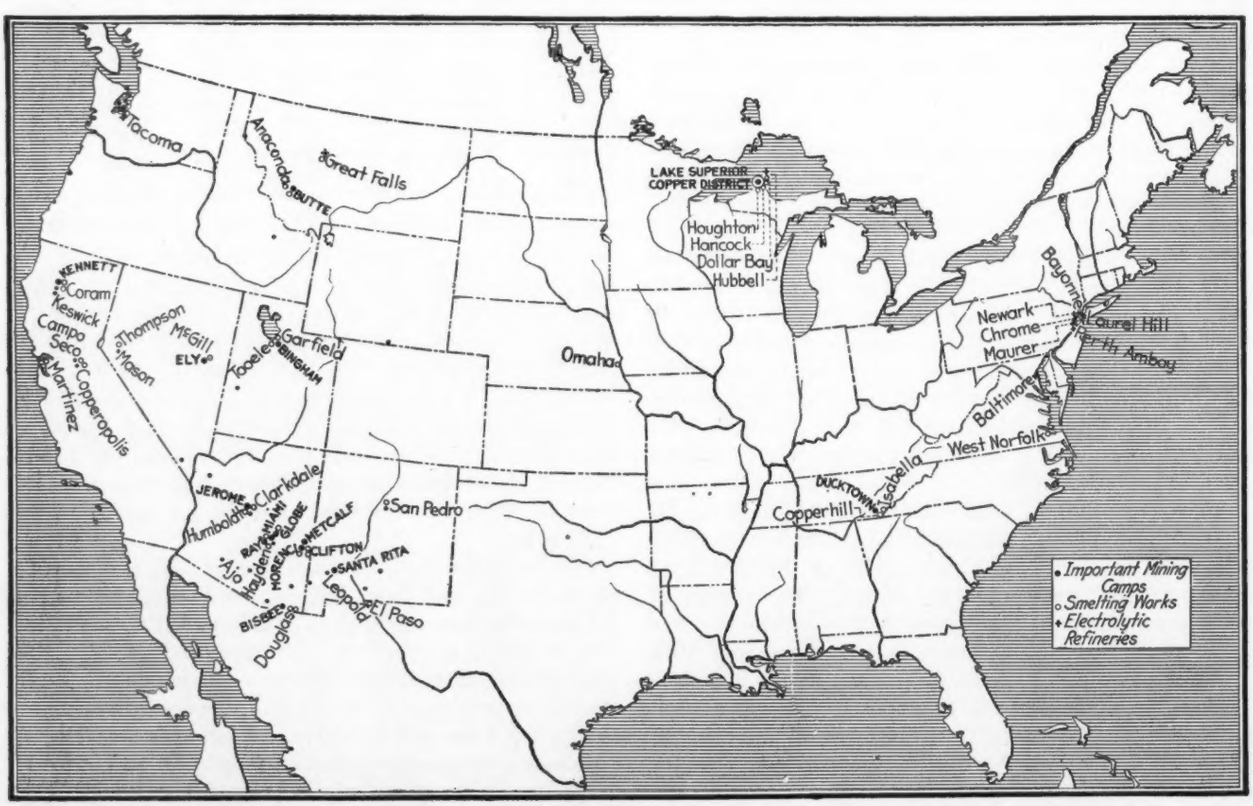
By B. B. Thayer*

Last year was a record year, so far as prosperity was concerned, throughout the entire Butte district, and this condition was reflected generally throughout the State of Montana. On account of the high prices received for all the metals, production was at its maximum and all the companies produced at least their normal output.

The Butte & Superior made its largest output in zinc on record, and there is no indication at the present time of any check during 1916. What has been said of the Butte & Superior applies likewise to the properties operated by W. A. Clark, and the prediction made a number of years ago—namely, "that Butte would become as important a factor in the production of zinc as it had been in the production of copper"—has been fulfilled.

The Pilot-Butte company was in litigation during 1915 with the Anaconda company over the ownership of certain orebodies, and the case is still in the courts. The

*Vice-President, Anaconda Copper Mining Co., New York.



PRINCIPAL COPPER-MINING DISTRICTS, SMELTING WORKS AND ELECTROLYTIC REFINERIES IN THE UNITED STATES

Alex Scott company operated continuously with results very satisfactory to the management, it is stated. The officials of the East Butte company reported satisfactory progress and are contemplating more extensive operations.

The condition of the mines of the Anaconda company improved very materially during 1915, and developments therein were very gratifying. The new work undertaken at the Washoe reduction works was practically completed, and all of the improvements, when in full operation, will reduce considerably the cost of copper production. The Anaconda company will probably enter the field as a zinc producer on a large scale, as a process has been evolved at the Washoe works which it is thought will to a certain extent revolutionize the metallurgy of zinc, in that no smelting whatsoever is carried on in the reduction of the zinc ore, the process being entirely leaching and electrolytic precipitation.

[The Anaconda electrolytic zinc process is described elsewhere in this issue.—Editor.]

Copper Production in Michigan

By James MacNaughton*

Last year was one of gradual and continuous improvement. At the end of 1914 practically all the nonproducing mines were closed and all the producing mines except Mohawk and Wolverine were running at reduced rates. The situation improved rapidly, so that the close of 1915 found all the producing mines pushing production to the limit and all nonproducing mines again in operation.

The new properties to enter the copper-production class during 1915 were the South Lake, New Arcadian and White Pine. The production of the first two mentioned has been limited to an occasional mill run, but White Pine has been a steady producer on a limited scale since April. This rock has been much advertised by the newspapers as being phenomenally rich. This statement is probably made because of the inherent optimism of the correspondents and the isolation of the property. The facts are that the rock is but little richer than the average of the district. Exploration in the neighborhood of the White Pine has led to the organization of the White Pine Extension Mining Co., the only new incorporation in this district during 1915.

If 1915 was notable for increased activity in the consumption and production of copper, it was no less so in the effort to produce cheaply without its being at the expense of the wage earner. Wages have been gradually raised as the price of copper warranted it, until they are now the highest ever known in the district. Contract work and bonus systems underground have been extended so that the willing and efficient miner or trammer can make almost double the basic rate. The use of the Carr bit has resulted in an increased output per miner equivalent to his total output of a few years ago. This increased efficiency shows itself not only in decreased costs, but more especially in making available tremendous tonnages of low-grade ore that would not otherwise be commercial. At the Copper Range mines the use of sand filling for stopes has been continued and a closer selection of rock underground has resulted in a decided lowering in the cost per pound of copper produced.

At the several mills the changes have been along the line of increased efficiency, chiefly by reason of lower power cost and finer crushing. The use of the low-pressure steam turbine following the steam stamp has become standard; Ahmeek, Champion and Isle Royale put in this equipment during 1915. The Copper Range Co. is increasing its fine-grinding capacity as power permits, using Hardinge mills and steel balls. Calumet & Hecla began the recrushing of its accumulated tailings during 1915, and results have exceeded expectations. This installation is the largest tailings plant in existence, having available over 35,000,000 tons of material, all lying within a radius of less than a mile.

The excellent results of 1915 were accomplished by friendly feeling and coöperation between employer and employee. Most of the companies showed a willingness to share their prosperity with the men to an extent beyond the immediate necessities of the labor market. With the continuance of this coöperation the Lake Superior copper district faces a future brighter even than the past, for every decrease in cost carries with it the ability to extend the field of operation to ore otherwise below the point of profitable extraction.

ELECTROLYTIC COPPER REFINERIES OF THE UNITED STATES

Works	Situation	1912 Capacity, Pounds	1913 Capacity, Pounds‡	1914 Capacity, Pounds‡	1915 Capacity, Pounds‡
Nichols Copper Co.	Laurel Hill, N. Y.	400,000,000*	400,000,000	400,000,000	400,000,000
Raritan Copper Works	Perth Amboy, N. J.	360,000,000†	400,000,000	400,000,000	400,000,000
Baltimore Copper Smelting and Rolling Co.	Canton, Md.	312,000,000*	348,000,000	336,000,000	354,000,000
American Smelting and Refining Co.	Perth Amboy, N. J.	192,000,000*	216,000,000	216,000,000	240,000,000
United States Metals Refining Co.	Chrome, N. J.	180,000,000*	200,000,000	200,000,000	200,000,000
Balbach Smelting and Refining Co.	Newark, N. J.	48,000,000*	48,000,000	48,000,000	48,000,000
Anaconda Copper Mining Co.	Great Falls, Mont.	65,000,000*	65,000,000	65,000,000	65,000,000**
Tacoma Smelting Co.	Tacoma, Wash.	36,000,000*	36,000,000	48,000,000	120,000,000
Calumet & Hecla Mining Co.	Buffalo, N. Y.	55,000,000*	55,000,000	§	§
Calumet & Hecla Mining Co.	Calumet, Mich.	.....	.....	65,000,000‖	65,000,000
Totals		1,648,000,000	1,768,000,000	1,778,000,000	1,892,000,000

* Official figures furnished by the respective companies. † Estimated. ‡ All of the figures for 1913, 1914 and 1915 were officially furnished. § Buffalo works of Calumet & Hecla dismantled in fall of 1914. ‖ New works put into operation in 1914. ** New refinery of Anaconda company, now in construction, will have a capacity of about 180,000,000 lb.

Smelting at West Norfolk, Va.

The smeltery at West Norfolk, Va., is equipped to produce 20 tons of blister copper from ore per day. Electrolytic copper is being successfully produced direct from roasted pyrite cinder from the sulphuric-acid works, although from some solutions cement copper is being produced. The residue, after the copper is extracted, is sintered and sold for the production of iron in iron and steel works.

The Virginia Smelting Co. has begun the production of liquid SO_2 from waste smeltery gases and is reclaiming very valuable land on one of the best harbors in the United States by filling in the mud flats with slag from the smeltery. A pier of slag has already been built 1,500 ft. out to deep water.

*Second vice-president and general manager, Calumet & Hecla Mining Co., Calumet, Mich.

In this plant ore is smelted for the recovery of copper, silver and gold, after it has been mined in Butte, roasted at Kansas City to produce sulphuric acid, and smelted in Oklahoma for the recovery of the zinc. Pyrite is mined in Canada, roasted in Massachusetts, New Jersey, New York and Pennsylvania, and the cinder is smelted at West Norfolk or the copper is leached out and precipitated and the cinder sintered.

Kennecott Mines in Alaska

By Stephen Birch*

During 1915 the copper mines near Kennecott owned by the Alaska Syndicate were transferred to the Kennecott Copper Corporation, and the stock of this company was placed on the market. These mines produced from the time of the formation of the Kennecott Copper Corporation, May 27, 1915, to Nov. 30, 1915, approximately 52,000,000 lb. of copper, averaging about 8,660,000 lb. per month, at a cost of under 5c. per lb. During November the production exceeded 10,000,000 lb.

The developments in the Jumbo mine were especially remarkable. On the 500-ft. level of this mine there is a stope that averages over 70% copper for a width of 70 ft. All the ore from this stope is shipped directly to the smelters and returns between 1,350 and 1,500 lb. of copper per ton. Some of the ore from other parts of the mine is first concentrated in a mill situated at a lower altitude, about three miles from the mine, with which it is connected by an aërial tramway. Construction of a leaching plant to treat the tailings from the concentrator was commenced during 1915. Additions and improvements to the concentrator have resulted in increasing its capacity to 800 tons per day.

Prospecting in the district was not carried on as energetically during 1915 as formerly, principally because so many men were attracted to the line of the new railway being built by the Government from Seward.

*President, Kennecott Copper Corporation, New York.

Copper-Smelting Works of North America

The accompanying table, corrected up to Dec. 1, 1915, gives the names of the companies engaged in copper smelting in the United States, Canada and Mexico; the situation of their works, the number of their smelting furnaces and the estimated annual capacity in terms of tons of charge, meaning ore and flux, but not including fuel. It should be noted, however, that not all of the furnaces reported are in operation all the time. In most cases the data have been communicated to the *Journal* by the operating companies. However, the figures should be taken as only approximately correct. Some companies may have figured their annual capacity on the basis of the year of 365 days, and others on the basis of 350 days, or something else. Anyway, annual capacity is a rather variable figure. In modern practice a rather large quantity of ore is reduced directly to copper by charging it into the converter along with matte, this being shown separately in some cases by the last column of the table.

COPPER-SMELTING WORKS OF NORTH MERICA

Company	Situation of Works	No. of Blast Furnaces	Annual Capacity	No. of Reverberatory Furnaces	Annual Capacity	No. of Converters	Annual Capacity in Ore*
American Smelting and Refining Co	Aguascalientes, Mex	10	800,000	..	.....	4	†
American Smelting and Refining Co	Perth Amboy, N. J	1	90,000	..	.....	3	†
American Smelting and Refining Co	Omaha, Neb	..	.....	..	.....	2	†
American Smelting and Refining Co	El Paso, Tex	3	300,000	3	435,000	3	†
American Smelting and Refining Co	Matehuala, S.L.P., Mex	3	325,000	..	.....	..	.....
American Smelting and Refining Co	Hayden, Ariz	..	.....	2	290,000	3	†
American Smelters Securities Co	Garfield, Utah	4	800,000	6	875,000	6	†
American Smelters Securities Co	Tacoma, Wash	2	375,000	..	.....	7	†
American Smelters Securities Co	Velardeña, Dgo., Mex	3	250,000	..	.....	..	.....
Anaconda Copper Mining Co	Anaconda, Mont	3	1,750,000	8	1,750,000	7	105,000
Anaconda Copper Mining Co	Great Falls, Mont	2	280,000	2	330,000	2	49,000
Arizona Copper Co	Clifton, Ariz	..	.....	3	360,000	3	.....
Balakala Consolidated Copper Co.††	Coram, Calif	3	630,000	1	52,500	2	.....
Compagnie du Boleo	Santa Rosalia, Mex	8	650,000	..	.....	..	.....
British Columbia Copper Co	Greenwood, B. C	3	912,500	..	.....	2	.....
Calumet & Arizona Mining Co	Douglas, Ariz	2	649,500	4	486,500	6	33,500
Canadian Copper Co	Coppercliff, Ont	7	1,020,000	2	300,000	5	43,200
Cananea Consolidated Copper Co	Cananea, Son	8	868,000	2	153,000	6	35,000
Consolidated Arizona Smelting Co	Humboldt, Ariz	..	.....	2	150,000	2	10,000
Consolidated Mining and Smelting Co	Trail, B. C	5	450,000	..	.....	2‡	.....
Copper Queen Consolidated Copper Co	Douglas, Ariz	10	1,225,000	3	275,000	7	34,160
Detroit Copper Mining Co	Morenci, Ariz	1	132,657	..	.....	3	7,578
Ducktown Sulphur, Copper and Iron Co	Isabella, Tenn	2	171,500	..	.....	..	.....
East Butte Copper Mining Co	Butte, Mont	2	350,000	..	.....	3	5,000
Granby Consolidated Mining, Smelting and Power Co	Grand Forks, B. C	8	1,440,000	..	.....	4	7,000
Granby Consolidated Mining, Smelting and Power Co	Anyox, B. C	4	1,080,000	..	.....	3	28,000
International Smelting Co	Tooele, Utah	..	.....	5	525,000	5	14,000
International Smelting Co	Miami, Ariz	..	.....	3	420,000	5	7,000
Mammoth Copper Mining Co	Kennett, Calif	5	730,000	..	.....	2	28,500
Mason Valley Mines Co.††	Thompson, Nev	2	800,000	..	.....	2	22,000
Mazapil Copper Co.††	Concepcion del Oro, Zac. Mex	4	250,000	..	.....	..	.....
Mond Nickel Co	Coniston, Ont	3	630,000	..	.....	3	70,000
Mountain Copper Co	Martinez, Calif	..	.....	3	125,000	2	**
Nevada Consolidated Copper Co	McGill, Nev	1	175,000	5	900,000	4	40,000
Nichols Copper Co	Laurel Hill, N. Y	2	94,500	..	.....	2	.....
Norfolk Smelting Co	West Norfolk, Va	1	140,000	..	.....	2	4,200
Old Dominion Copper Mining and Smelting Co	Globe, Ariz	5	562,500	..	.....	1	6,062
Orford Works, International Nickel Co	Constable Hook, N. J	2	94,500	..	.....	3	.....
Penn Mining Co	Campo Seco, Calif	1	50,000	2§	96,000	..	.....
Pioneer Smelting Co	Corwin, Ariz	1	60,000	..	.....	..	.....
Santa Fe Gold and Copper Co	San Pedro, N. M	1	45,000	..	.....	..	.....
Shannon Copper Co	Clifton, Ariz	3	500,000	..	.....	2	8,000
Swansea Consolidated Gold and Copper Mining Co	Bouse, Ariz	1	190,300	..	.....	2	.....
Tennessee Copper Co	Copperhill, Tenn	7	1,000,000	..	.....	4	15,000
Teziutlan Copper Mining and Smelting Co.††	Teziutlan, Puebla, Mex	2	350,000	..	.....	3	.....
Cia. Metalurgica de Torreon	Torreon, Coah., Mex	2	175,000	..	.....	2	.....
Tyee Copper Co.††	Ladysmith, B. C	2	175,000	..	.....	..	.....
U. S. Metals Refining Co	Chrome, N. J	2	200,000	..	.....	2	†
U. S. Smelting Co.††	Midvale, Utah	6	670,000	1	40,000	4	36,000
United Verde Copper Co	Clarkdale, Ariz	4	720,000	3	324,000	5	54,000
Wanakah Mining Co	Ouray, Colo	2	105,000	..	.....	..	.....
Western Sm. & Power Co.‡	Cooke, Mont	1	.....	..	.....	..	.....

* Raw ore smelted as flux. † Included in furnace tonnages. ‡ Under construction. § Penn. Min. Co. has 2 reverberatories, each with capacity of 48,000 tons per annum, but only one is run at a time. ** No raw ore charged. †† Not in operation.

Copper Production in Chile

By Pope Yeatman*

During the first half of 1915 the nitrate industry was by no means in a prosperous condition, many of the plants having been shut down in 1914 because of the European war, and others operating on reduced time. During the second half of the year, however, the industry has been getting back to normal conditions, and the production is said to be equal to the average. High freight rates and difficulty in getting shipping of any kind have greatly interfered with shipments.

The copper-mining industry was also at a low ebb during the early part of 1915, owing to general business depression and low prevailing prices of metal, high freights and restricted markets, the war having cut off many of the European smelters having agencies in South America. Later in the year the high price of copper tempted the smaller producers to resume and increase operations.

The smelteries at Catemou, Naltagua, Chañaral, Caldera, Calama, Lota and Gatico have been running, the last especially with a greatly increased production. The mines at Collahuassi also were operated.

The Braden Copper Co. continued its operations and greatly increased its production, the plant now being large enough to handle 4,500 tons of ore per day. Designs are being made for an increase to a capacity of 10,000 tons per day.

The plant of the Chile Exploration Co., at Chuquicamata, was officially started up in May and is now on an operating basis. Actual construction was begun in January, 1913—a little over two years for building the plant, which is designed for the treatment of 10,000 tons of ore per day. Mining is by steam shovel, and the treatment consists of crushing to about a maximum of ½ in., leaching with sulphuric acid and precipitation of copper from solution electrolytically.

Work at the iron mine of the Bethlehem Chile Iron Mines Co., at Tofo, consists of preparing for large production and, for this purpose, especially in work on a landlocked harbor and docks. Considerable shipments of ore were also made.

A great deal of work was done under the direction of William Braden in the way of prospecting, and preparations are now being made to open the Potrerillos copper mine, situated about 90 mi. back of Chañaral.

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Copper Production in Arizona

By Walter Douglas†

The restriction of production initiated in August of 1914 continued in force until after the first quarter of 1915, when, owing to the recovery of the metal market and the increased demand, operations were resumed on a normal basis.

In July, 1915, the Inspiration Copper Co. and the associated works of the International Smelting Co. at Miami entered the ranks of the producers, and while maximum production was not attained during 1915, the output served to offset in a measure the loss in production through the strike in the Clifton-Morenci district, which has closed down the mines of the Arizona Copper Co., the Detroit Copper Mining Co. and the Shannon Copper Co. since September.

During 1915 the new smelting plant of the United Verde Copper Co., at Clarkdale, was put into operation, and being modern and efficient, it will permit of an increased production of copper from the mines of that company and an active participation in the custom-ore business of the northern part of the state.

In the Warren district the Copper Queen satisfactorily concluded its concentration experiments and will shortly decide upon the plans for a commercial unit for the treatment of its disseminated and aluminous ores. The Calumet & Arizona continues to increase its output of copper at its Bisbee mines and, having completed the exploration of its New Cornelia property, is, in conjunction with the El Paso & Southwestern Railroad Co., constructing a railroad from Gila on the Southern Pacific to the mines at Ajo. The treatment of the Ajo ores involves an interesting metallurgical problem, involving the leaching of the oxides and carbonates and the electrical deposition of the copper from solution, and later, the concentration by flotation of the sulphides. The availability of the orebody for steam-shovel mining will serve to give minimum mining costs, the overburden being negligible.

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Copper Mining and Metallurgy in Arizona

By L. D. Ricketts*

During the last eight months of 1915 all the copper mines of Arizona were worked at full capacity, with the exception of those of the Clifton-Morenci district, which have been closed down by a strike since September. The works of the Arizona Copper Co., at Clifton, and of the Calumet & Arizona Mining Co., at Douglas, have been very successful in getting satisfactory costs and savings. The new reduction works of the United Verde Copper Co. at Clarkdale, and those of the International Smelting Co., at Inspiration, were blown in during 1915 and are in successful operation. All of these four large works are equipped with adequate crushing and sampling works, calcining furnaces, reverberatory furnaces and Great Falls type of basic-lined converters, 12 ft. in diameter. The Douglas and Clarkdale plants are also equipped with blast furnaces.

The striking features brought out in 1915 in the development of the copper industry in Arizona lie in the continued and successful efforts to obtain low unit costs and greatly increased savings in order to meet high labor costs, and at the same time to convert into great and profitable mines certain immense masses of mineralized rock that a comparatively few years ago were uncommercial.

Power Plants

The leanness of the ores in the new great mines demands great tonnages, and the necessity of a high recovery demands fine grinding. As a consequence, the amount of power consumed is great and the generation of cheap power is a necessity. The tendency has been

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†General manager, Phelps, Dodge & Co., New York.

*Consulting engineer, 42 Broadway, New York.

toward the adoption of the steam turbine in comparatively large units in a central power house, the generation of electric current and the distribution of this current to mine, mill and smeltery for power purposes.

The Inspiration Consolidated Copper Co., in conjunction with the International Smelting Co., built and put into operation during the year a new power plant containing three 7,500-kv.-a. steam turbines with accessories, and three reciprocating converter blowing engines, each having a capacity of 15,000 cu.ft. of free air per minute and delivering the air at 15 lb. pressure. This plant, which was designed and constructed by C. C. Moore & Co., is exceeding its guarantees and giving perfect satisfaction. In the future, however, it is probable that the turbo-blower, driven by steam turbine or motor, will supersede the reciprocating engine. The contracting firm was in no way responsible for the adoption of the reciprocating engine.

The introduction of the Diesel engine has been receiving attention, and as American manufacturers develop this type of engine and gain experience, it will doubtless be adopted in some of our plants. As long as the reverberatory furnace is used, however, the use of steam is obligatory, in part at least, in most central plants.

Mining Methods

In mining in Arizona, the departure of the Ray Consolidated in adopting the shrinkage system, devised by Mr. Cates at Bingham and Ray, is successful, and satisfactory costs are being obtained. At the Miami mine a part of the ore from the top of its great orebody is being top-sliced with a mattress, but its management is also adopting the shrinkage system and is obtaining very creditable costs. At Inspiration Mr. Mills has been systematically developing the mine, and Mr. McDonald, the underground superintendent, is introducing the Ohio system of mining, which is now in successful operation in a form modified to suit Inspiration conditions. In adopting the inclined raise, the extraction drifts are placed 100 ft. apart and the tramming system is much simplified. Compressed-air locomotives are used underground instead of the trolley. The Ray 5-ton car, which is a mere box on wheels, is used, and the ore is dumped into pockets in three revolving tipples of the Ray type, but each taking five cars at a time instead of three. The two duplex-drum hoists, equipped with 12-ton skips, are electrically driven. They are coupled together and operated mechanically and alternately in half-cycles. An Ilgner motor-generator set furnishes the direct current for these hoists and equalizes the otherwise heavy peaks. Up to June last the Inspiration mine produced but 700 tons a day for its experimental mill. In June two of the 18 sections of the mill were put in operation, and at the end of December 11 units were in operation, while the remaining 7 units should be in operation early in 1916. The mine has easily responded to the demand of the mill. In December over 210,000 tons was mined, and the management believes the mine can produce 14,000 tons of ore a day when the mill calls for it. If so, in nine short months this mine will have developed from a small producer into possibly the largest single underground mine in point of tonnage in the world.

By the use of either the shrinkage method or the Ohio method of mining, there is necessarily some waste mixed with the ore. With the use of flotation this does not vitiate the recovery of the sulphides. While such dilution requires greater mill capacity for a given output, besides the cost of milling such waste, the diminished mining cost will far more than counterbalance this and may even approach the cost of steam-shovel mining.

The Flotation Process

Upon information furnished the Inspiration company by the Minerals Separation company, experiments leading to the saving of copper sulphides by flotation were begun about 2½ years ago, and the success of this process has since been demonstrated. When the ratio of concentration of a given ore is very high, as at Inspiration, and a new mill has to be built, flotation becomes the major process and gravity concentration supplements it, but where practically new and fine mills like those at Ray and Miami are in operation or where the ratio of concentration is comparatively low, as at Clifton, the gravity method may, or should be, the major process, and flotation should be supplementary. In the former case, as at Inspiration, the ore is crushed initially in Marcy steel-ball mills to pass 48-mesh. Tar and other oils are fed into the ball mill, and the pulp passes to flotation cells. The tailings are divided into slimes, which are again treated by flotation, and sands, which are classified and passed to tables. The other large mills of Arizona use progressive crushing and gravity concentration, and they have all done valuable and excellent work in the introduction of supplemental plants for the treatment of tailings by flotation. In some cases, so far only slimes and fine sands are treated, but doubtless they will all come to regrinding the coarser sands to the necessary extent.

The relative merits of the short tube mill and the Hardinge mill have not been determined. The short tube mill is giving satisfaction at Inspiration. I have no doubt that the Hardinge mill will do equally good work, and it may possess some advantages. In either case the striking feature of these mills is their ability to take ore as coarse as a 4-in. cube and crush it to pass a 48-mesh screen at one operation.

Various types of flotation machines are in use in the West. The Callow machine, the Inspiration machine (designed by Dr. Gahl) and the Cole machine represent various types of pneumatic machines. The Hebbard machine of the Minerals Separation Co., which retains the mechanical beaters but introduces compressed air under the impellers, also seems to give gratifying results.

Oxidized Copper Ore

From 10 to 15% of the total copper in our so-called chalcocite ores is in the form of oxidized copper minerals. Of the copper existing as sulphide, from 90 to 92% may be recovered by flotation, with proper grinding, and only about 30% of the oxidized copper minerals are saved. Experiments indicate that certain compounds will permit of a high recovery by flotation of copper carbonates. I doubt if silicates will respond equally, because such mineral is often disseminated through the pores of the rock like ink in a blotter.

There has been a decided decrease in smelting costs, but this decrease has not been as radical as the decrease in power, mining and milling costs, nor as important, for it applies only to a concentrated product and not to the total tonnage. Larger units in calciners and fur-

naces, the electrostatic precipitation of dust and capital expenditure to assure accurate sampling and cheaper handling charges are factors.

The New Cornelia Copper Co., at Ajo, Ariz., now controlled by the Calumet & Arizona Mining Co., has a large tonnage of carbonate and silicate ores, containing about 1.5% copper, which cap the sulphide ores and which may be mined by steam shovel with practically no stripping. After preliminary experiments, the company operated throughout 1915 a test leaching plant of 40 tons' daily capacity. Using sulphuric acid as a solvent, from 80 to 85% of the copper is dissolved when the ore is crushed to 4-mesh and treated by continuous upward percolation in tanks having a column of ore from 10 to 12 ft. high.

Electrolytic Precipitation

In order to recover from 0.9 to 1 lb. of copper per kilowatt-hour in the electrolytic plant, with hard-lead anodes, the ferric iron has to be kept under control by the use of sulphurous acid added in absorption towers. A neutral solution of copper sulphate and other salts absorbs the gas more readily than an acid solution. Experiments in this electrolytic plant, with carbon anodes, air agitation and the use of sulphurous acid, confirmed the results given by Mr. Addicks in his most valuable paper, but experiments with this method at Ajo have not gone far enough to demonstrate with any degree of certainty that it can be used without serious mechanical difficulties, without displacement and loss of sulphuric acid by air, and without serious annoyance to the workmen from sulphurous-acid gas.

The favorable results obtained in this test plant have led the company to decide to erect a leaching plant of a capacity of 4,000 tons a day. This development is very important because of the great quantities of lean oxidized copper ores at other places in Arizona. Inspiration alone has 18,000,000 tons of such ore, with possibilities of an even larger tonnage, and I understand that at Ray they have similar deposits.

The success of the great so-called porphyry mines in Arizona is the result of years of creditable work by able men. This year has shown that a great mass of copper-sulphide-bearing rock, having a high ratio of concentration, when favorably situated may be profitably exploited if it contains 1% of copper or over, and the indications to me point with certainty to our being able to attack in another decade such complex ores of still leaner character.

Cuba and Trinidad in 1915

The success of the Matahambre copper mine in Cuba stimulated prospecting throughout the island, and some small shipments were made from these prospects. The Matahambre mine in the Province of Pinar del Rio shipped about 40,000 tons, averaging over 12% Cu; the mine is now open to a depth of 300 ft. The Cuba Copper Co. finished the unwatering of its mine near Santiago de Cuba and completed its 700-ton Minerals Separation flotation plant; the company milled about 600 tons daily of 3% copper ore, besides making monthly shipments of from 2,000 to 3,000 tons of 7% ore. Near Bayamo, McLoughlin Bros. continued development work on a copper property and began the erection of a small smelting furnace. Prospecting was continued at the Carlotta pyrite mine, north of Cienfuegos, and was commenced at another pyrite mine, the Antonio, at Minicaragua, Santa Clara Province.

The Midvale Steel and Ordance Co. announced in December that it had obtained control of 300,000,000 tons of iron ore through the purchase of the Buena Vista Iron Co. in northeastern Cuba. The iron-ore shipments from Cuba were as follows: Nodules from Felton, 296,407 tons; raw ore, 4,617; Daiquiri, 245.088; Juragua, 187,000; El Cuero, 65,930. The Cauto Mining Co., a Rogers-Brown interest, shipped about 6,000 tons manganese ore.

The oil companies in Trinidad continued active exploitation, the leading companies being the United British Oil Fields of Trinidad, Trinidad Leaseholds, Ltd., and the Barber Asphalt Paving Co. The first company was shipping at the end of the year about double its former output. The Barber Asphalt Co., owing to difficulties in ocean transport, purchased a steamer in May, after which about 35,000 bbl. per month was shipped. Its asphalt shipments from Trinidad Lake showed a substantial increase over 1914, though European business was practically suspended.

Sulphur Industry in 1915

Sulphur production in the United States in 1915 was probably the greatest in the history of the industry. Louisiana and Texas furnished practically the whole output, the former state supplying the major part of this production as heretofore. The Union Sulphur Co., at Sulphur, La., maintained in 1915 its normal yearly output of about 375,000 tons, with four wells. In Texas, the Freeport Sulphur Co. added a third steaming plant at the Bryan Heights dome and was producing at the end of 1915 at the rate of about 300 tons per day; no figures of the year's output were obtainable from the company. No production except for local consumption was made in other states of this country, and the same was true of the other Americas.

The sulphur trade in the United States was decidedly slack during the first half of 1915, but improved gradually until at the end of the year there was a brisk trade. Stocks at the end of 1915, however, were greater than at any previous time. The slack conditions in the paper trade in the first half of the year reduced domestic consumption in 1915 to less than 300,000 tons. Export business was practically suspended owing to transport conditions, but late in the year the Union Sulphur Co. made two small shipments to Sweden and purchased a 9,000-ton steamer preparatory to resuming shipments to some of its European distributing stations. Prices remained practically stationary in the United States, but the Consorzio, which controls the Silician sulphur sales, is reported to have raised its prices late in the year. Japan at midyear was producing at an increased rate.

Necrology

Among the noted men identified with the mining and metallurgical industries who died during 1915 were the following:

Birkinbine, John	May	14	Hebgen, Max	Aug.	24
Derby, Orville A.	Nov.	27	Holmes, Joseph A.	July	12
Geikie, James	Mar.	2	Martin, Pierre	May	23
Greiner, Adolphe	Nov.	20	Schnabel, Carl	Jan	?
Guiterman, Franklin	May	8	Swank, James M.	June	21
Hahn, Otto H.	July	26	Tropenas, Alexander	July	14

Lead

The production of lead in the United States again showed an increase in 1915, the output of the refiners, both from domestic and foreign sources, attaining an unparalleled total of more than 600,000 tons. The Missouri smelters turned out about 20,000 tons more than in 1914, which means that the output of the Missouri mines increased in about the same ratio, inasmuch as this group

PRODUCTION OF LEAD (REFINERY STATISTICS)*

Domestic: Class	1912	1913	1914	1915
Desilverized	236,207	261,616	318,697	317,463
Antimonial	9,239	16,345	17,177	24,370
S. E. Missouri	145,366	133,203	177,413	197,427
S. W. Missouri	19,224	22,312	25,448	26,096
Totals	410,036	433,476	538,735	565,356
Foreign:				
Desilverized	82,715	54,774	28,475	47,405
Antimonial	5,003	2,300	1,119	2,492
Totals	87,718	57,074	29,594	49,897
Grand totals	497,754	490,550	568,329	615,253

* These figures include the lead derived from scrap and junk by primary smelters.

of smelters obtains but little ore from elsewhere than Missouri. The lead product of Idaho ores was about 175,000 tons, compared with about 155,000 tons in 1914. There was therefore an increase in the domestic output of about 40,000 tons from these two districts. It follows that some of the other lead-producing districts must have experienced decreases. In view of the fact that lead mining was arbitrarily curtailed during the early part of 1915, just as it was in the latter part of 1914, it is evident that the lead-producing capacity of the United States is in excess of the statistics reported for either year.

The imports of lead into the United States in 1915 are estimated by the United States Geological Survey at 9,625 tons in ore, 50,825 tons in base bullion and 400 tons in scrap, a total of 60,850 tons, compared with 28,338 tons in 1914. Of the imports in 1915 about 58,000 tons came from Mexico, against 23,141 tons in 1914.

The exportation of lead of foreign origin is estimated at 43,000 tons in 1915, compared with 31,051 tons in 1914; and of domestic origin, 76,000 tons, compared with 58,722 tons in 1914. The total exportation of lead from the United States was therefore 119,000 tons in 1915, against 89,733 tons in 1914.

The imports of lead in October and the 10 months ended Oct. 31 are reported by the Department of Commerce as follows in pounds:

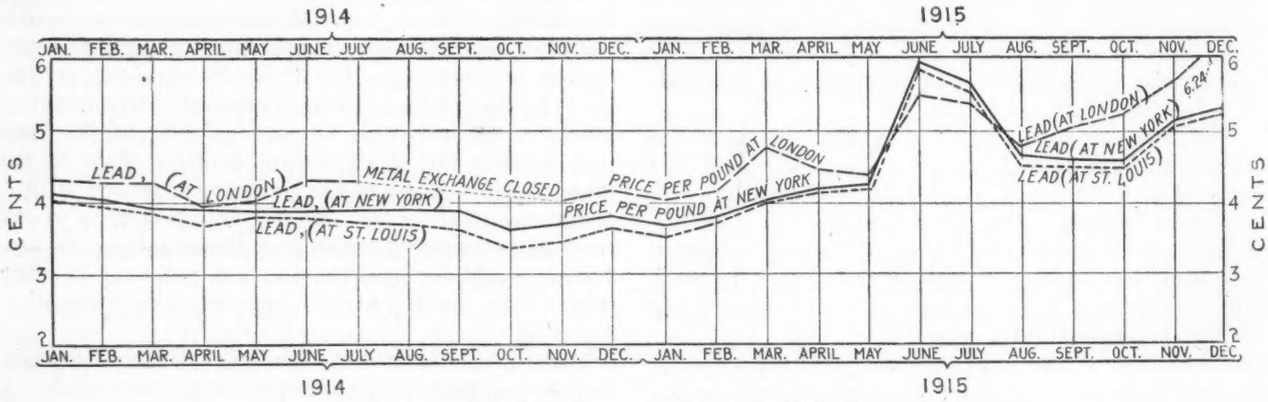
	October	Ten Months
Lead in ore	3,169,893	15,246,854
Lead in base bullion	13,359,856	81,651,884
Lead, pigs, bars, etc	16,605	768,843
Total imports	16,546,354	97,667,581

The weight of ore imported in October was 9,306 tons, chiefly from Mexico and Chile. The weight of bullion and base bullion was 13,767,422 lb., nearly all from Mexico.

Lead Market in 1915

First Quarter—At the opening the price for lead was 3.80c., New York. The statistics showing an increase of 100,000 tons in the domestic production in 1914, in spite of the curtailment in the last quarter, was a great shock and caused the market to decline to 3.65@3.70c. At that price some rather large sales were made, and about the end of January the market advanced to 3.80c. During February and the early part of March there were no features of special interest. On Mar. 15 some very large sales for export were made, and on Mar. 16 the American Smelting and Refining Co. was led to advance its price to 4.10c. The price of lead in London was far above our parity, but the difficulty of finding freight room kept the English and American markets apart. The differential between New York and St. Louis prices was much less than ordinarily, owing to the sales that were being made for shipment from St. Louis to Europe through Gulf ports. An estimate of the domestic consumption of lead at this time was about 65% of normal. During the last week of March large sales were again made, and the market advanced to 4.15@4.20c. New York, and 4.10@4.20c., St. Louis.

Second Quarter—During April lead was steady at 4.20 @4.25c., New York. In May inquiries for military purposes began to excite some interest, but the supply of lead appeared to be ample, and the market exhibited rather a softer tone, there being apparently a fear that any ma-



LEAD PRICES IN 1914 AND 1915—PLOTTED BY MONTHLY AVERAGES

MONTHLY AVERAGE PRICE OF LEAD

Month	New York 1913	New York 1914	New York 1915	St. Louis 1913	St. Louis 1914	St. Louis 1915	London 1913	London 1914	London 1915
Jan	4.321	4.111	3.729	4.171	4.011	3.548	17.114	19.665	18.606
Feb	4.325	4.048	3.827	4.175	3.937	3.718	16.550	19.606	19.122
Mar	4.327	3.970	4.053	4.177	3.850	3.997	15.977	19.651	21.883
Apr	4.381	3.810	4.221	4.242	3.688	4.142	17.597	18.225	21.094
May	4.342	3.900	4.274	4.226	3.808	4.182	18.923	18.503	20.347
June	4.325	3.900	5.932	4.190	3.810	5.836	20.226	19.411	25.170
July	4.353	3.891	5.659	4.223	3.738	5.531	20.038	19.051	24.611
Aug	4.624	3.875	4.656	4.550	3.715	4.520	20.406	*	21.946
Sept	4.698	3.828	4.610	4.579	3.658	4.490	20.648	*	23.151
Oct	4.402	3.528	4.600	4.253	3.384	4.499	20.302	*	23.994
Nov	4.293	3.683	5.155	4.146	3.585	5.078	19.334	18.500	26.278
Dec	4.047	3.800	5.355	3.929	3.662	5.266	17.798	19.097	28.807
Year	4.370	3.862	4.628	4.238	3.737	4.567	18.743	.....	22.917

New York and St. Louis, cents per pound. London, pounds sterling per long ton. * London Exchange closed.

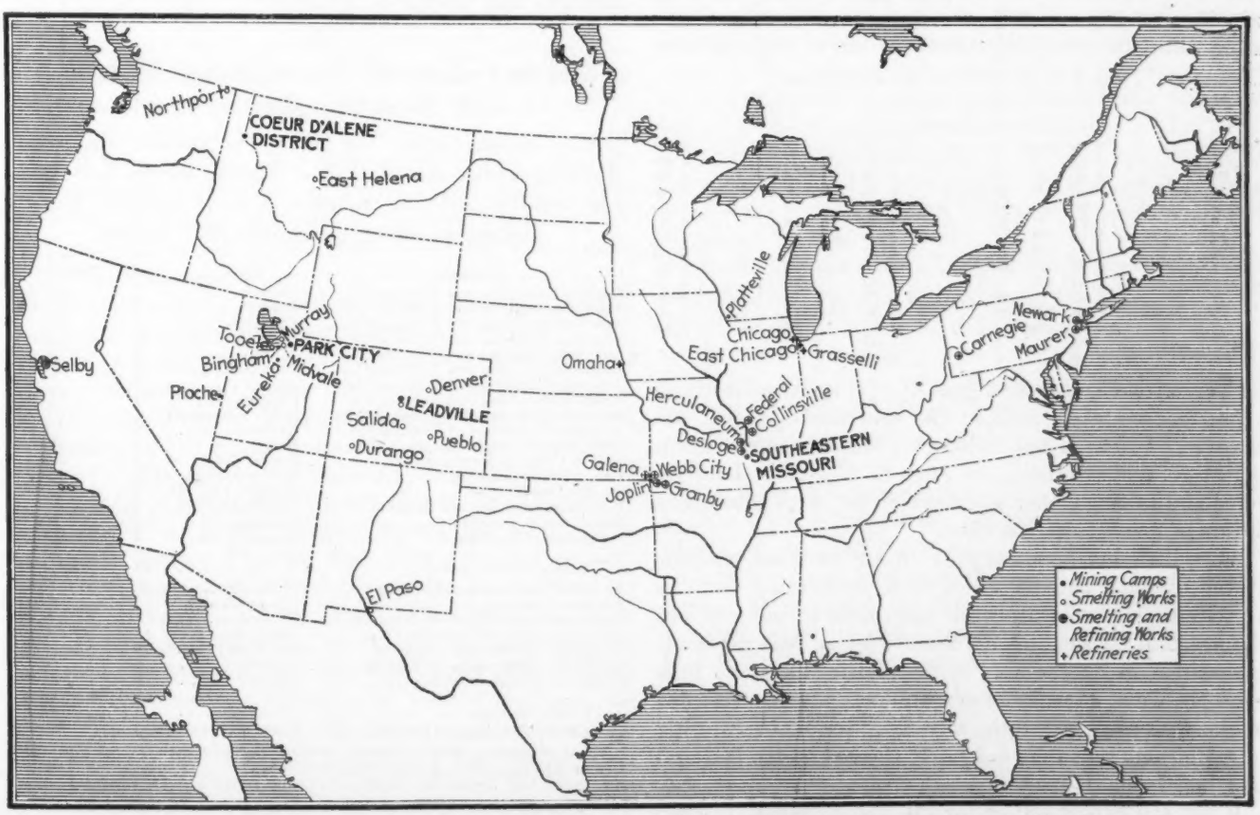
terial advance in the price would give too great a stimulus to production. Toward the end of May, however, a larger inquiry from ammunition manufacturers developed, and on May 25 the American Smelting and Refining Co. advanced its price to 4.30c., New York, which took most of the other producers by surprise. This started a spectacular advance in the price for lead. On May 27 the quotation was 4.40c.; on June 1, 4.90c.; on June 12, 7@8c.; on June 15, 6¾@7¼c.; on June 22, 5⅜@5¾c. The advance was well founded. Curtailment had reduced the supply to a greater extent than was supposed, and on the other hand the requirements for lead had increased to a greater extent than was supposed. Into this situation a powerful speculative clique injected itself. Several days in advance the tip was circulated in Wall Street that lead was going to 6c. or higher. Of course this inflamed buyers, who feared a repetition of what had happened in spelter. At about 6c. producers made very large sales, some of the largest transactions in lead ever recorded—10,000-ton lots and such—being made at this time. As the market rose further, the volume of transactions dwindled, and above 7c. was relatively small. At 8c. the speculators tried to liquidate, but found that there were no buyers. The market simply melted away under their feet. The producers took a stand at 5¾c. to stay the decline, but they did not regain control of the market until all the speculative lead had been liquidated. That appeared to have been accomplished about the end of June, at which time the market rallied and became firm at 5¾c.

Third Quarter—During July the market was dull and narrow, but throughout the month there was some shading of prices, and toward the close the American Smelting and Refining Co. made several sharp reductions, which brought the market down to 4½c. about the middle of August. At this level buyers evinced interest and placed some large orders, which cleared the atmosphere. An increased demand then developed, and higher prices were willingly paid. By the end of August the market had recovered to about 4.90@5c. Following this there was again a recession of price, the market standing at 4.50c. at the middle of September, and at the same price at the end of the month.

Fourth Quarter—Lead remained at about 4½c., New York, until Oct. 21, when the American Smelting and Refining Co. advanced its price to 4¾c., this having been justified by the considerable volume of business done during the month. Continued large business led to an advance to 4.90c. on Oct. 29, to 5c. on Nov. 4, to 5.15c. on Nov. 10 and to 5.25 on Nov. 15. About the end of November the market began to exhibit a stiffer tendency, but the American Smelting and Refining Co. did not raise its price, mystified by which independent producers became free sellers and the market turned distinctly easier. On Dec. 14 the American Smelting and Refining Co. unexpectedly raised its price to 5.40c., New York, and the market then became more active. At the close of 1915 lead stands at 5.50c. The consumptive demand is large, and the unsold stocks in the hands of producers are believed to be very small.

White Lead and Oxides in 1915

Prices of lead pigments fluctuated more violently and reached a higher level during the last six months than at any other period since commercial conditions became normal after the inflation during and following the Civil War. The indirect influence of the European War upon pig lead, and speculative operations in that commodity, caused a rapid advance during the latter part of May



PRINCIPAL LEAD-MINING DISTRICTS, SMELTING WORKS AND REFINERIES IN THE UNITED STATES

and resulted in a rise of over 2½c. per lb. before the middle of June. As a consequence, white lead in oil, which had remained at 6¾c. from Nov. 1913, to June 1, 1915, was advanced on the latter date to 7c., with further advances of ¼c. on the 4th, ½c. on the 7th and 1c. on the 9th, making the price on that date 8¾c., or 2c. per lb. above the figures that had ruled for more than 18 months prior to June 1.

A break in pig lead was promptly followed on June 22 by a reduction of 1c. in the price of white lead in oil, and subsequent reductions brought the price back on Aug. 19 to the level of June 1, 6¾c., thus covering an advance of 2c. per lb. and an equal decline in 2½ months. Since the last-named date there have been two advances, following pig lead, and at the close the minimum price is 7¼c. The frequent changes have had a more or less disturbing effect upon business, which was restricted by the extreme advance, but the sales for the year have been in excess of 1914 and reflect a heavier domestic consumption, as well as a considerable export business with the Latin-American markets.

Dry white lead has not followed closely the fluctuations recorded for lead in oil, but from an opening figure of 5c. there was a gradual advance to 5½c. during the first half of the year and in June corroders made a 7¾c. price as a safeguard against the uncertain future of pig lead. With the subsequent decline in the latter, dry lead settled back to a 6c. basis, but subsequently advanced to 6¼c., which is the quotation at the close, but with guarded selling on contracts running into next year.

Oxides were weak at the opening of the year and only began to stiffen up in April, when the pig-lead market showed a very positive advancing tendency. Red lead at that time advanced to 6c. and 6¼c. from an opening of 5½c. to 5¾c. and in the June rise went to 8¼c., after which there was a gradual decline to 6½c. in September, with a subsequent gain of ¼c. in November and again in December, making the minimum price at the close 7c. Litharge has followed a similar course, opening at 5c. and advancing in June to 8¼c., but later reacted and in September was down to 6c., with subsequent advances to 6½c. at the close.

A. S. & R. CO. PRICES FOR PIG LEAD

New York Delivery
(In Cents per Pound)

Opening	3.80	June	4	5.20	Aug.	10	4.50
Jan. 12	3.70	"	7	5.50	"	25	4.60
" 28	3.80	"	8	5.75	"	26	4.70
Feb. 15	3.85	"	10	6.25	"	27	4.90
Mar. 1	3.90	"	11	6.50	Sept.	9	4.70
" 5	3.95	"	12	7.00	"	14	4.50
" 17	4.10	"	17	6.25	Oct.	22	4.75
" 24	4.15	"	18	6.00	"	29	4.90
Apr. 1	4.20	"	19	5.75	Nov.	4	5.00
May 21	4.30	"	21	5.00	"	10	5.15
" 27	4.40	"	26	5.75	"	15	5.25
" 28	4.50	July	30	5.50	Dec.	14	5.40
" 31	4.75	Aug.	2	5.25	"	31	5.50
June 1	4.90	"	7	5.00			
" 3	5.00	"	9	4.75			

Very little business was done in any of these products at the extreme figures, which were established more as a precautionary measure while the course of pig lead was so uncertain. Even now the market for all lead pigments is sensitive to fluctuations in the metal, and at no time since the June advance have manufacturers felt justified in guaranteeing prices for any long period or entering into contracts that were not fairly covered by the material they had in sight.

While the export outlet for all lead pigments reached increased proportions during the year, manufacturers still regard this business as one of doubtful permanency, although there are gratifying evidences that on an even price basis a large share of it could be retained against any foreign competition.

The cost of linseed oil has had a strengthening effect on the price of white lead in oil throughtout the year, having advanced steadily from an opening figure of 48c. per gal. to 65c. in May, with fluctuations between that figure and 60c. since, about 62c. being the closing figure.

A. S. and R. Co's Mines, Mexico

By S. W. Eccles*

The American Smelting and Refining Co. operated most of its mining properties in the northern part of Mexico until September, 1915, at which time operations were suspended and the American and foreign employees were withdrawn to the United States in compliance with a request made by the United States Government.

At Santa Eulalia the scale of operations was almost normal. At Santa Barbara mining and milling were increased to normal basis. At Velardeña the Copper Queen and Teneras mines were operated. At Sierra Mojada the mines were worked on a reduced scale. In the southern section of Mexico, the Angangueo and Tepezala properties were operated on a reduced basis. The production has been stocked on the surface pending reopening of railroad transportation.

No work was done at Charcas or at Matehuala during 1915, owing to the almost complete interruption of railroad service. From the Bonanza, Zaragossa and Reforma properties some shipments were made. Railroad conditions are improving somewhat, so that operations at the properties situated in the central and southern districts may shortly be resumed.

Silver-Lead Smelting Works of North America†

The accompanying list gives the several silver-lead smelting works of the United States, Mexico and Canada, together with the number of their furnaces (in all

AMERICAN SILVER-LEAD SMELTING WORKS

Company	Place	Furnaces	Annual Capacity(*)
American Smelting and Refining Co.	Denver	7	510,000
American Smelting and Refining Co.	Pueblo	7	380,000
American Smelting and Refining Co.	Durango	4	210,000
American Smelting and Refining Co.	Leadville	10	510,000
American Smelting and Refining Co.	Murray	8	657,000
American Smelting and Refining Co.	East Helena	4	306,000
American Smelting and Refining Co.	Omaha (†)	2	82,000
American Smelting and Refining Co.	Chicago (†)	1	36,000
American Smelting and Refining Co.	Perth Amboy (†)	4	170,000
American Smelting and Refining Co.	El Paso	6	380,000
Selby Smelting and Lead Co	Selby	3	210,000
Ohio & Colorado Smelting Co	Salida, Colo.	4	345,000
United States Smelting Co	Midvale, Utah	6	500,000
Needles Smelting Co	Needles, Cal. (‡)	2	70,000
Northport Smelting and Refining Co.	Northport, Wash	2	.....§
Pennsylvania Smelting Co	Carnegie, Pa.	2	60,000
International Smelting Co	Tooele, Utah	5	525,000
Totals, United States		78	4,951,000
American Smelting and Refining Co.	Monterey	10	584,000
American Smelting and Refining Co.	Aguascalientes	1	40,000
American Smelting and Refining Co.	Chihuahua	7	400,000
American Smelters Securities Co	Velardeña	3	150,000
Compañia Metalurgica Mexicana	San Luis Potosi	10	250,000
Compañia Metalurgica de Torreon	Torreon	8	360,000
Compañia Minera de Peñoles	Mapimi (‡)	6	325,000
Totals, Mexico		..	2,109,000
Consolidated Mining and Smelting Co.	Trail, B.C.	4	140,000

*Tons of charge. † Smelt chiefly refinery between-products. ‡ Not operated in 1914 and 1915. § Plant being remodeled.

*Vice-President, American Smelting and Refining Co., New York.

†Corrected to Dec. 1, 1915.

cases, blast furnaces) and their estimated annual capacity in tons of charge. By "tons of charge" is meant ore and flux, but not coke. The ton of charge is manifestly the correct unit. In the case of a self-fluxing ore, the ton of ore smelted and the ton of charge smelted is the same thing. In other cases fuel and labor have to be used in smelting the flux as well as in smelting the ore, and the economy of smelting depends largely upon the percentage of ore in the charge. The management of this question is about the highest exercise of the metallurgist's skill.

The figures in the accompanying table are in most cases from official communications of the respective companies. Estimated capacity is, however, always a matter of more or less uncertainty, and for this reason, if for no other, the figures given ought to be accepted only as approximations. The figures have been corrected from last year, but the totals remain about the same. There was in fact no new construction of consequence in 1915. The Northport, Wash., plant has been taken over by the Hercules interests and is being remodeled, and Bunker Hill & Sullivan expects to build a new plant in 1916, so that lead-smelting capacity will soon be materially increased.

The total capacity of the Mexican works is a little over 2,000,000 tons per year; of the American works, a little over 4,800,000 tons. With respect to the American works, at least, such capacity has never been in use at one time. More or less of it represents capacity that has become idle because of changes in the conditions of ore supply.

The Southeastern Missouri Lead District

By H. A. Wheeler*

The Southeastern, or disseminated-lead, belt of Missouri produced about 178,000 tons of pig lead in 1915. This maintains the long, almost unbroken record of the continuous growth of this district, as last year's output exceeds the previous high record, or that of 1914, by about 15,000 tons, or 9%. The bumper production last year is especially noteworthy, as there was a marked curtailment during the first part of the year, when the lead market was very low, or less than 4c. per lb. in St. Louis. With the improvement in prices that took place in April, the district tuned up to full speed and finished the year under full pressure and great activity.

St. Francois County produced nearly 95% of the output of southeastern Missouri in 1915 from the mines of the St. Joe, Federal, National, Desloge and Baker lead companies in the Bonne Terre, Big River and Flat River districts. These mines all produce from the deep, low-grade, large disseminated deposits that occur at depths of 100 to 600 ft. in the "Bonne Terre" limestone. The numerous shallow diggings that were worked a century ago were abandoned 30 to 40 years ago in St. Francois County and were always small producers; they have proved invaluable, however, to the modern prospector in indicating where to drill for the deeper disseminated lead; for the relation between the shallow lead and the deep disseminated deposits has proved most intimate in St. Francois and Madison Counties. The shallow diggings in Washington County, which adjoins St. Francois on the west, did not produce much lead in 1915, nor did Franklin County to the north. Jefferson County, which is immediately north of St. Francois County, has a few shallow diggings that contain both lead and zinc, and under the stimulus of the high zinc market in 1915 produced a limited amount of zinc carbonate and galena.

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New Prospecting on a Big Scale

The great improvement in market conditions stimulated considerable prospecting in the last half of the year. The operators are beginning to realize that desirable unabsorbed land in St. Francois County is steadily diminishing and that it will not be long before they will have to cross the line into Washington County to maintain their future ore reserves. While the drilling will be deeper, slower and more costly, or to depths of 500 to 1,200 ft. at $1.25 to $1.75 per ft. in Washington, as compared with 200 to 600 ft. at 50c. to $1 per ft. in St. Francois County, it is low when compared with diamond drilling in other mining districts, where $2 to $5 per ft. is the usual range. That Washington County is likely to eclipse St. Francois within the next 20 years or less is quite probable, if the most reliable guide to successful prospecting in St. Francois and Madison Counties—shallow lead diggings—also holds true in Washington County. For the shallow diggings are much richer, more numerous and cover larger areas in Washington County than in St. Francois, unless the county line should prove to be a disseminated-lead dam. The county line did not prevent some of the surface-lead deposits from slopping over from Washington into St. Francois County, yet the average native, as well as some "higher up" is convinced that it trapped all the disseminated-lead solutions and prevented them from making similar deposits in Washington County under identically the same geological conditions as occur in St. Francois County.

One Eastern syndicate is already prospecting near Irondale, in the southeastern part of Washington County, where it has optioned considerable land that was secured by H. J. Cantwell, the veteran who successfully unearthed several deposits in the Flat River district.

A St. Louis syndicate is also drilling near Potosi, on the eastern side of Washington County, where an encouraging core of disseminated lead was obtained in 1913 at depths of 827 and 930 ft.

The flotation process is making further headway in recovering the lead from the slimes, and it has been adopted by all the large mills. In fact, the recovery of the formerly lost lead has made such progress that further pollution of Big River, into which all the St. Francois County slimes finally drain, is no longer considered probable, and the old damage suits have been settled on this basis.

The labor situation has been very satisfactory throughout the district during the past year, as there have been plenty of men and no strikes. When the price of lead took the sharp upward turn, there was a clamor for higher wages that resulted in giving the men a bonus of 25c. per day, which is still continued, although the price of lead has considerably receded.

St. Francois County

The St. Joseph Lead Co. had a most successful year in 1915 under its new régime and made by far the largest output in its long, highly successful career. This was mainly due, however, to the absorption of the Doe Run

Lead Co., with which it has always been closely affiliated and which was taken over by the parent company in 1914 on a stock basis. Ten shafts were operated that furnished the ore, via the Mississippi River & Bonne Terre R.R., which it owns, for the old 1,500-ton mill at Bonne Terre, for the 1,500-ton mill at Owl Creek (on Big River) and for the 4,000-ton Doe Run mill at Rivermines, in the Flat River district. The original mine at Bonne Terre, which is nearly 50 years old and was the first disseminated mine in the district, is still a large and active producer. The smelter at Herculaneum, on the Mississippi River, was further improved and can now treat 12,000 tons of concentrates per month with a high efficiency as regards recovery. The Peugnet tract at Bonne Terre has been optioned at $1,000 per acre and is now being drilled.

Changes in St. Joe Staff

There have been many changes in the local management during the last year, including the death of Roscoe Parsons, former general manager, and the retirement of O. M. Bilharz, who is now identified with zinc mining in the Joplin district. Mr. Bilharz was superintendent of the Doe Run company for over twenty years and later of the St. Joe company and the designs of the new mills at Owl Creek and Rivermines were executed in his office. The death of Roscoe Parsons removes the last of the Parsons from Bonne Terre, an attractive, model mining town that owes its existence and development to this family. For it was his father, Charles Parsons, the first superintendent of the St. Joe company, that finally made a success of the enterprise after years of struggling with poverty and technical difficulties, and on his successful retirement in later life, he was succeeded by his oldest son Roscoe, whose untimely death occurred last summer.

The Desloge Lead Co. pursued its usual policy of quietly pushing production to its top notch and maintaining its plant in excellent condition. It operated three shafts that supplied its 1,600-ton mill on Big River at the town of Desloge. While most of the concentrates were shipped to a custom smelter in the East St. Louis district, its small plant of Flintshire or air furnaces at Desloge were kept in operation, as usual—a type of smelting this company has tenaciously adhered to, at least on a moderate scale. This company operates its own railroad between the scattered shafts and mill, which connects with the Mississippi River & Bonne Terre R.R. at Desloge station.

The National Lead Co.'s mines are at St. Francois station, in the Flat River district, where it operates four shafts on a compact body of land that is equipped with an excellent 2,000-ton mill. A central rockhouse situated near the mill is employed, to which all the ore is hauled from the scattered shafts by an electric trolley system, the only one used in the district. All the ore is sampled and weighed before it is milled, and all of the mill products are sampled and assayed, thus giving complete information as to the actual work of the mill. The concentrates are shipped to the National company's large smeltery at Collinsville, Ill., which also does custom work. The plants were run at full capacity during 1915 and turned out the largest output in their history. Options were taken on considerable St. Francois County land, which is now being drilled, and several tracts were purchased.

The Federal Lead Co. operated seven shafts in 1915 on its very extensive property in the Flat River district, from which the ore is hauled by its own railroad to a central rockhouse and 4,000-ton mill on the land acquired from the old Central Lead Co. To appreciate the magnitude of its operations and to realize the difficulties of wasting such a heavy tonnage of resulting tailings, one has only to glance at the huge pile—or rather, young mountain—of tailings that has accumulated in the short life of this mill, which is the largest in the district. Although advantage was taken of a draw or gentle valley near the mill in which to dump the tailings from a high wire-rope tramway, this was soon outgrown, and now a rubber-belt conveyor set at a high angle is employed, to which "dummies," or extensions, are built as "Mount Federal" enlarges.

A new shaft, No. 12, was started last August that will be 460 ft. deep. It will be equipped with an electric hoist that will operate two 4½-ton skips. The concentrates are shipped to its large smelting plant at Alton, Ill., which operates on the open-hearth and baghouse principle and also does custom work.

New Boston Interests Active

The Baker Lead Co., of Boston, succeeded the St. Francois Lead. Co. in the ownership of the old Jake Day land on Big River. This is a tract that was peddled on the market for years, and almost every operator in the district has optioned it and turned it down, after more or less drilling. Boston interestes finally took it over at about $1,200 an acre on the strength of the previous drill records and sunk a shaft on the edge of Big River. It opened up one of the richest orebodies in St. Francois County, as mill runs for month after month on careful sampling assayed from 8 to 11% lead, as compared with a district average of 3 to 6%. The company has no mill, and the ore is being treated under a long-time contract by the National Lead Co., with whose mill it is connected by a spur of the Mississippi River & Bonne Terre R.R.

The Baker company recently acquired the "Jones Forty," a 40-acre tract between the old Central and Derby lands at Elvins, that is claimed to be very rich. At the reported price of $100,000, or $2,500 per acre, this is the highest price yet paid for drilled but undeveloped farm lands, as the previous high was $1,500 an acre. This property sold 15 years ago for $6,000, or $150 an acre, when it was undrilled, although within a mile or so of good mines. A shaft has been started that will be 625 ft. deep, one of the deepest in the district.

Madison County

The Mine la Motte Co., which operates the classic lead mine of America, had an active year and made the largest output in its history. Since the present company took hold two years ago, it has adopted several original ideas, the most important of which is to rework the shallow diggings with steam shovels, in milling which there is quite a recovery of carbonate of lead. The disseminated orebodies are also being actively worked.

The Phœnix mine, formerly known as the Catherine, was reopened last spring and is again being worked under lease by the Federal Lead Co. The adjoining Fleming tract is also being worked, as the Catherine orebody extends into this land. The North American mine, at Fredericktown, is still closed down, and its costly smeltery is sadly suffering from disuse.

Zinc

The production of spelter by ore smelters in the United States was 492,495 tons in 1915, compared with 362,361 tons in 1914. This includes the spelter derived both from domestic and foreign ores and also a small tonnage obtained from dross, etc., by smelters whose chief business is the reduction of ore. It is to be noted that there is also a rather large production of spelter by dross smelters, pure and simple. Their production is not included in the present report.

The total reported for 1915 is the aggregate of the reports of 32 smelters operating 42 works. So far as we know, these were all of the smelters who produced in 1915; but in view of the starting up of new works like mushrooms, it is possible that one or two new concerns escaped attention. The list of the zinc smelters, together with the number of their retorts at the end of 1915, is given in an accompanying table.

In reporting their production, all of the smelters gave their output up to Dec. 15, together with their own estimate for the remaining fortnight of the year; but to a large extent the reports came by telegraph after the end of the year, and consequently represent the actual output without any estimate.

SPELTER PRODUCTION IN 1914 AND 1915 BY QUARTERS
(Reports of Ore Smelters Only)
(In tons of 2,000 lb.)

District	I	II	III	IV
1914				
Illinois	31,005	32,482	32,512	34,588
Kansas-Missouri	13,939	14,659	15,193	11,633
Oklahoma	22,563	22,960	22,945	23,999
Others (*)	20,700	20,703	21,819	22,661
Totals	88,207	90,804	90,469	92,881
1915				
Illinois	35,748	40,062	42,084	44,275
Kansas-Missouri	13,807	24,568	31,921	40,007
Oklahoma	25,213	26,984	28,603	29,602
Others (*)	23,268	27,217	28,028	31,108
Totals	98,036	118,831	130,636	144,992

(*) With the exception of one plant in Colorado these are all Eastern works. In the fourth quarter of 1915 is included Anaconda production.

PRODUCTION OF SPELTER
(In tons of 2,000 lb.)
By Ore Smelters

States	1911	1912	1913	1914	1915
Colorado	7,477	8,860	8,637	8,152	8,881
Illinois	88,681	94,902	111,551	130,587	162,169
Missouri-Kansas	106,173	111,761	85,157	53,424	110,303
Oklahoma	46,333	76,837	83,230	92,467	110,402
East	47,172	56,278	69,687	77,731	100,740
Totals	295,836	348,638	358,262	362,361	492,495

All of these smelters reported their production by quarters, which figures are summarized in a separate table. That table shows how the output increased quarter by quarter. In the last quarter of 1915 the zinc smelters of the United States were producing spelter at the rate of 580,000 tons per annum.

It is a fair assumption that all of the retorts listed were in use at the end of 1915, excepting such small proportion of them as were necessarily cold for repairs. At the end of the year there were new retorts under construction by the Edgar Zinc Co. at Donora, Penn., the La Harpe Spelter Co., and the Oklahoma Spelter Co., at Kusa, Okla.; the Henryetta Spelter Co. at Henryetta, Okla., the American Spelter Co. at Pittsburg, Kan., the American Zinc and Chemical Co. at Langeloth, Penn., the Bartlesville Zinc Co., at Collinsville, Okla., the Robert Lanyon Zinc and Acid Co. at Hillsboro, Ill., the Iola Zinc Co. at Concreto, Kan., United States Zinc Co. at Sand Springs, Okla., and several others, to the number of 23,234. In addition to this an electrolytic plant designed to produce 35,000 tons of spelter per annum was under construction at Great Falls, Mont.

The stock of spelter at works on Dec. 31, being the aggregate of the reports of all the smelters, was 14,300 tons, compared with 23,500 tons at the beginning of 1915. These figures include both high-grade and common spelter.

The exports of spelter in 1915 are estimated at 128,000 tons, compared with about 70,000 tons in 1914.

Spelter Market in 1915*

First Quarter—At the beginning of 1915 the price for spelter was about 5.60c. The publication of the statistics showing that the domestic stock had been reduced to about 20,000 tons started good buying and an upward movement in the market. A large export business in high-grade, intermediate and brass special spelters had been going on right along, owing to the need for those kinds in making ammunition. As early as the first week of January, high-grade spelter was selling for about 10c. per lb. and intermediates for 7½@8½c., with brass specials in proportion, while a premium of 5 to 10 points was being realized on such sorts of prime Western as could be guaranteed a trifle better than the official limits respecting lead and iron contents.

MONTHLY AVERAGE PRICE OF SPELTER

Month	New York 1913	New York 1914	New York 1915	St. Louis 1913	St. Louis 1914	St. Louis 1915	London 1913	London 1914	London 1915
Jan.	6.931	5.262	6.386	6.854	5.112	6.211	26.114	21.533	30.884
Feb.	6.239	5.377	8.436	6.089	5.228	8.255	25.338	21.413	39.819
Mar.	6.078	5.250	8.541	5.926	5.100	8.366	24.605	21.460	44.141
Apr.	5.641	5.113	10.012	5.491	4.963	9.837	25.313	21.569	49.888
May	5.406	5.074	14.781	5.256	4.924	14.610	24.583	21.393	68.100
June	5.124	5.000	21.208	4.974	4.850	21.038	22.143	21.345	100.614
July	5.278	4.920	19.026	5.128	4.770	18.856	20.592	21.568	97.250
Aug.	5.658	5.568	12.781	5.508	5.418	12.611	20.706	†	67.786
Sept.	5.694	5.380	13.440	5.544	5.230	13.270	21.148	†	67.841
Oct.	5.340	4.909	12.800	5.188	4.750	12.596	20.614	†	66.536
Nov.	5.229	5.112	15.962	5.083	4.962	15.792	20.581	25.016	88.409
Dec.	5.154	5.592	15.391	5.004	5.430	15.221	21.214	27.369	89.409
Year	5.648	5.213	13.230	5.504	5.061	13.054	22.746	.....	67.553

New York and St. Louis, cents per pound. London, pounds sterling per long ton. † Not reported.

About the middle of January the spelter market had become so excited that it was hard to quote it accurately. The advancing tendency had been apparently foreseen by certain sellers, who themselves were large buyers on the way up. The price continued to advance by leaps and bounds, and at the end of January stood at about 7½c. At this point a deadlock by exhaustion seemed to have been reached. The producers had sold out all of their stock and all of the metal they expected to make in February, except what was reserved for regular customers, to be settled for at the market. March-April spelter was still available, but consumers, skeptical of the advance, which they thought to be a put-up job, did not exhibit much interest in entering into forward contracts. The smelters in all quarters reported the firing up of furnaces that were idle at the beginning of January, at which time there were a good many cold retorts, not including what were in the moribund works in Kansas. High-grade spelter was reported to have realized 15 to 17c.

During February the market continued to advance, and the premiums for prompt deliveries rose higher and higher, while producers found difficulty in interesting buyers in the usual contracts running two or three

*Throughout this article the prices quoted refer to the market on the basis of St. Louis.

months ahead. By the middle of February there was no longer any wholesale market in spelter for prompt delivery, for the reason that all supplies except occasional odd lots had been exhausted. At this time it was first rumored that some Australian ore was coming to this country for smelting here. Early in March spelter touched 10c., and that price was spoken of as killing consumption for purely industrial purposes. Alarming news was received respecting this situation, especially among the galvanizers. This led producers to believe that they had been riding the whirlwind a little too long, and beginning on Mar. 4, strenuous efforts were made to place tonnages for any deliveries from April onward. This idea occurred to many sellers at the same time, and all kinds of efforts were made in the attempt to find a market. About Mar. 10, April-May and May-June spelter was offered in large lots at 8c., with intimation of better terms to anyone who wanted to do business. Even with such a cut, buyers could not be found. Resale offers from several consumers appeared as a disturbing factor. However, the news of a strike among the smelters in Oklahoma on Mar. 13 called a halt pending observation as to what this would amount to. The smelters demanded 50c. per day advance in wages all around. On Mar. 17 it was reported that a compromise had been effected.

ZINC-SMELTING CAPACITY OF THE UNITED STATES

(Number of Retorts at End of Years)

Name	Situation	1914	1915
American Spelter Co.	Pittsburg, Kan.	(‡)	896
American Zinc and Chem. Co.	Langeloth, Penn.	864	3,648
American Zinc Co. of Ill.	Hillsboro, Ill.	4,000	4,000
American Zinc, Lead and Smg. Co.	Dearing, Kan.	3,840§	4,480
American Zinc, Lead and Smg. Co.	Caney, Kan.	3,648†	6,080
Bartlesville Zinc Co.	Bartlesville, Okla.	5,184	5,184
Bartlesville Zinc Co.	Collinsville, Okla.	8,064	10,080
Chanute Spelter Co.‖	Chanute, Kan.	1,280§	1,280
Cherokee Smelting Co.	Cherokee, Kan.	(***)	896
Clarksburg Zinc Co.	Clarksburg, W. Va.	2,712**	3,648
Collinsville Zinc Co.	Collinsville, Ill.	1,536§	** 1,536
Edgar Zinc Co.	St. Louis, Mo.	1,100	2,000
Edgar Zinc Co.	Cherryvale, Kan.	4,800	4,800
Edgar Zinc Co.	Donora, Penn.	(‡)	3,648
Granby Mining and Smg. Co.	Neodesha, Kan.	3,840	3,760
Granby Mining and Smg. Co.	E. St. Louis, Ill.	3,240	3,220
Grasselli Chemical Co.	Clarksburg, W. Va.	5,760	5,760
Grasselli Chemical Co.	Meadowbrook, W. Va.	6,912	8,592
Hegeler Zinc Co.	Danville, Ill.	1,800**	3,600
Henryetta Spelter Co.	Henryetta, Okla.	(‡)	600
Illinois Zinc Co.	Peru, Ill.	4,640	4,640
Iola Zinc Co.	Concreto, Kan.	(‡)	660
Joplin Ore and Spelter Co.	Pittsburg, Kan.	(***)	1,440
J. B. Kirk Gas and Acid Co.††	Iola, Kan.	(***)	3,440
Kusa Spelter Co.	Kusa, Okla.	(‡)	3,710
La Harpe Spelter Co.*	Altoona, Kan.	3,840†	3,960
La Harpe Spelter Co.	Kusa, Okla.	(‡)	‡‡‡
La Harpe Spelter Co*	La Harpe, Kan.	1,856**	1,924
Lanyon Smelting Co.	Pittsburg, Kan.	(***)	448
Robert Lanyon Zinc and Acid Co.	Hillsboro, Ill.	1,840	1,840
Lanyon-Starr Smelting Co.	Bartlesville, Okla.	3,456	3,456
Matthiessen and Hegeler Zinc Co.	La Salle, Ill.	5,256	6,168
Mineral Point Zinc Co.	Depue, Ill.	9,080	9,068
National Zinc Co.	Bartlesville, Okla.	4,260	4,260
National Zinc Co.	Springfield, Ill.	3,200	3,200
Nevada Smelting Co.	Nevada, Mo.	(‡‡)	672
New Jersey Zinc Co. of Penn.	Palmerton, Penn.	5,760	6,720
Oklahoma Spelter Co.	Kusa, Okla.	(‡)	‡‡‡
Owen Spelter Co.†††	Caney, Kan.	(‡)	1,280
Pittsburg Zinc Co.§§	Pittsburg, Kan.	910§	910
Prime Western Spelter Co.	Gas City, Kan.	4,768	4,868
Sandoval Zinc Co.	Sandoval, Ill.	896	896
Tulsa Fuel and Manufacturing Co.	Collinsville, Okla.	6,232	6,232
United States Zinc Co.‖ ‖	Sand Springs, Okla.	4,000	5,680
United States Zinc Co.	Pueblo, Colo.	1,920	2,208
Totals		120,494	155,388

* Taken over by U. S. Smelting Co. in June, 1915. † Inactive during latter part of year. ‡ Plant built in 1915. § Inactive throughout year. ‖ Taken over by American Metal Co. in June, 1915. ** No report received; entered the same as previous year. †† Taken over by U. S. Smelting Co. in July, 1915. ‡‡ Plant was being dismantled in 1914, but later was repaired and reopened. §§ Operated by American Metal Co. since April, 1915. ‖ ‖ Formerly Tulsa Spelter Co. *** Old plant dropped from list years ago, but renewed in 1915. ††† Operated by Amer. Zinc, Lead and Sm. Co. ‡‡‡ Not yet operating.

Second Quarter—During the remainder of March the market remained dull and easy, but the beginning of April galvanizers began to exhibit more interest and the market started up again. By the middle of the month the price for spelter was about 9@9½c. and there was being exhibited an increased willingness in some buying quarters to enter into contracts for delivery further ahead than theretofore. Toward the end of April the market began to become crazy. Inspired by the spectacular rise in the price of spot spelter at London, dealers, traders and speculators ran away with this market. The transactions were of extraordinary character, being in the main for deliveries ranging all over the remainder of the year. At the end of the month the price was quoted at 11½@14c. This level of price was simply paralyzing of consumption for ordinary purposes. The largest galvanizing interest of the United States was reported to be frankly advising its customers to use painted sheets instead of galvanized. London reported that the government was taking bright wire instead of galvanized.

During May the market rose perpendicularly, transactions of extraordinary volume being consummated. The buying was mostly by ammunition manufacturers. Many of these had phenomenally lucrative contracts, the profit from which rendered the price paid for spelter almost immaterial. The chief thing in their minds appeared to be to contract for all the spelter they were going to require in filling their orders. Prices were at sixes and sevens, differences of cents per pound being recorded in the same office on the same day. At the end of May the market was quoted at 20@22c. On June 4 the quotation was 24@27c.

At this point ammunition makers appeared to have satisfied their requirements or were disposed to hold off and await developments, while as for the galvanizing business, it has been simply paralyzed. Consumers were freely offering spelter for resale and were unable to find buyers. This situation led to a rapid decline, and on June 23 the quotation was 16@18c. This was followed by a rally, but it was not characterized by any such crazy buying as there has been early in the month. At the end of June the quotation was 19@21c.

AVERAGE PRICE OF ZINC SHEETS

(In Cents per Pound)

	1914	1915		1914	1915		1914	1915
January	7.44	9.25	May	7.00	19.13	September	8.50	16.00
February	7.25	12.38	June	7.00	20.25	October	8.07	16.00
March	7.10	13.50	July	7.00	27.00	November	8.00	20.00
April	7.00	14.13	August	7.38	18.80	December	8.55	22.00

Average for the year 1914—7.524; year 1915—17.37 cents.

Note:—These are base prices for ordinary size sheets, in carload lots, f.o.b. Lasalle-Peru, Ill., less 8% discount.

Third Quarter—A new top was recorded on July 9 at 20@22½c. Reports of old smelteries being repaired and new furnaces and new works being built came from all quarters, a large increase in production being thereby promised. A renewed relaxation in the demand led to a secondary decline, liberal supplies being offered from numerous quarters. By early August the market showed all the earmarks of demoralization. Speculators who wanted to liquidate, manufacturers who had overbrought and wanted to resell and the weaker producers exerted pressure. Stocks of metal available for prompt delivery began to increase. Rather than sell such metal at the existing market, some producers anticipated deliveries on their later contracts.

At the middle of August spelter stood at about 10c. per lb. At this time there suddenly developed a rather important buying demand, in which some very large domestic consumers figured, their orders being taken at about 10c. per lb. England then commenced buying and took a considerable tonnage at about 10½c. This lifted the market out of the doldrums, and a further advance ensued on relatively small business. Toward the end of the month the United States Steel Corporation again

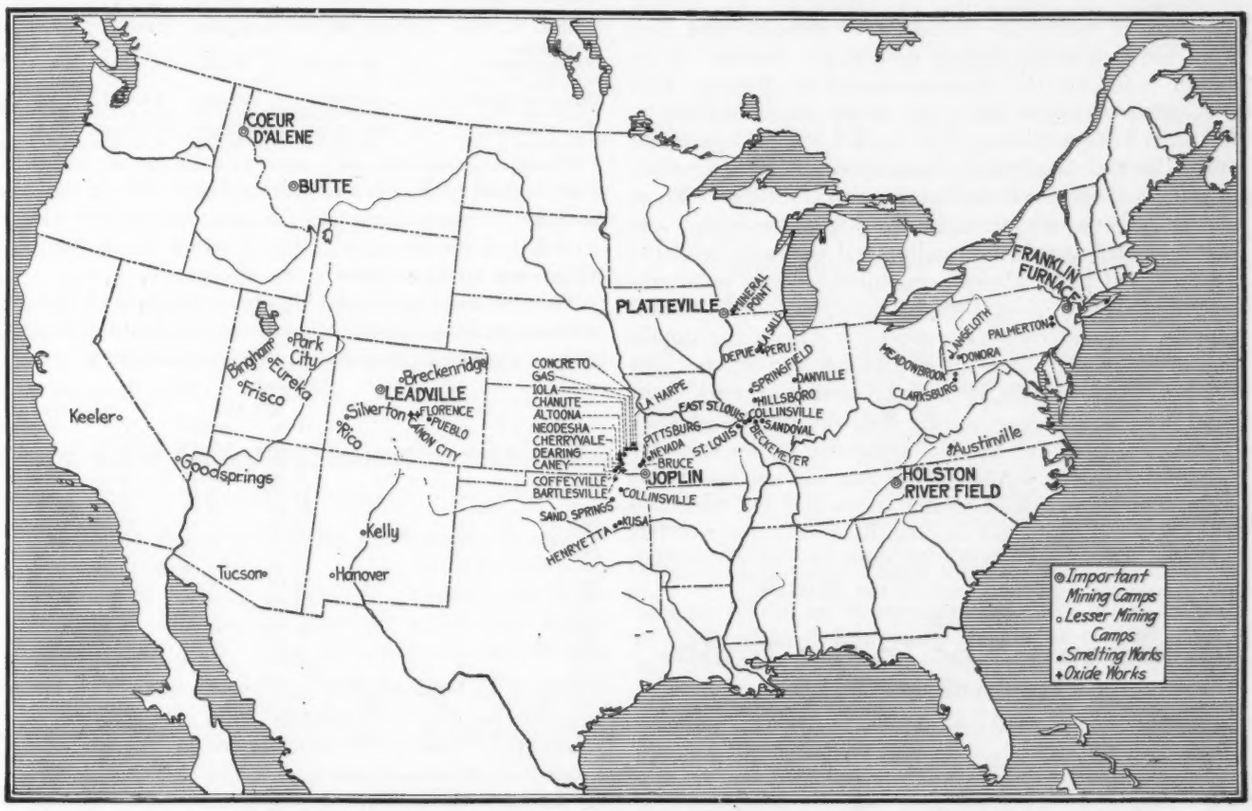
bought a large quantity of spelter at a sharp advance in price. This buying, together with other orders, created confused and excited conditions, similar to what prevailed when spelter was 10c. higher. The market rose to 15@16½c. The large demand having been filled, buyers again became conspicuous by their absence, and sellers immediately exhibited once more their desire to get spelter off their hands, with the natural result that the price began to sag off again. By the middle of September the price had fallen to about 12½@13c. A curious feature at this time was the offering of spelter for immediate delivery by the principal domestic consuming interest. Another rally put the market up to 13@14c. at the end of September.

Fourth Quarter—During the early part of October the market drooped, and about the middle of the month was quoted at 10½@13c. A moderately large business was done at this time at an average of about 12⅜c. There developed then a rather large volume of business, which was done chiefly with foreign buyers, especially for export to France. In the main it was done in contracts for deliveries running far ahead, ranging from contracts covering the first quarter of 1916 to contracts beginning immediately and running through the first quarter of 1916 and even further. At the end of October the price was about 13½@14½c.

In November the volume of business increased, domestic consumers figuring in the market, certain prominent galvanizers being large buyers, both for delivery in the immediate quarter and in the following one. The price advanced steadily, and at the end of the month the market was quoted at 15½@18½c. On relatively small business in the early part of December, the market experienced a severe decline, for which there was apparently no special reason except that the foreign demand, which previously had been the backbone of the market, had ceased, temporarily at least. Toward the middle of the month, however, there was a sharp and equally incomprehensible advance, which continued up to the close of the month, when the quotation was 15¼@16¾c.

Summary—The spelter market during 1915 was characterized after the first month, or perhaps the first fortnight, by an absence of stock on hand; that is, the market lost its balance wheel and consequently was highly erratic. This caused the small supplies of spelter available for prompt delivery to command a premium throughout the year, but of course the volume of this premium business was relatively trifling. During the first quarter buyers were reluctant to enter into the usual two-month and three-month contracts. During the second quarter not only would they do so, but also they bought eagerly for delivery right through the remainder of the year. At this time and later the operations of dealers, speculators and traders added to the confusion. After spelter touched 10c. in March, there had been a relapse to 8c., and experts were expecting a complete collapse of the position, which was already beyond all precedent in the spelter industry. In May and June ammunition contractors bought spelter as if there were never going to be any more of the metal made. At about 25c., however, the madness exhausted itself.

In the third quarter prophecies of a steady decline to 8c. or 6c. per lb. by the end of the year was general, owing to the large increase of capacity that was known to be going on. These prophecies failed utterly of realization, the reason being that the new production did not develop so rapidly as it was thought it would. However, during the third and fourth quarters there was a perfect



LEADING ZINC MINING AND SMELTING CENTERS IN THE UNITED STATES

appreciation that the great expected addition to supply was simply delayed, and consequently there was a general eagerness on the part of producers to place contracts for distant deliveries at prices far below what they would accept for the quarter immediately following. These conditions produced a wide range of price and made it difficult to say at any time what was the average position of the market.

The price for high-grade spelter, which was 10c. at the beginning of 1915, rose to 40c. and declined to 35c. This phenomenal price led to considerable new production of this sort of metal, and in the latter part of 1915 there was accumulation of unsold stocks of it, but the price was held firmly at 35c. per lb.

The gyrations in the spelter market completely upset the ore market. For a long time the price for ore failed to advance anything like in proportion of spelter. This caused many ore producers to consider that they were being unfairly treated, and at the demand of the Joplin producers the attorney-general of Missouri filed a complaint against about all of the zinc smelters, on the ground of conspiracy. The United States Department of justice was also led to inaugurate an inquiry. Both of these actions evaporated in their own silliness. There was at all times a plethora of ore supply, the high prices that were being paid for spelter and the large smelting margins that the smelters were enjoying being premiums on the possession of smelting capacity, not on the possession of raw material. The price for ore in the Joplin market did indeed rise to unprecendented figures, but never in proportion to the price of spelter. On the other hand, miners who were selling their ore on sliding scale contracts got the full benefit of the rise in the price for spelter. At certain times of the year the supply of zinc ore was so large that it became impossible for miners to make new contracts for it, and in some cases smelters canceled contracts. Large importations of Australian ore played an important part in the situation.

Lead and Zinc in the Joplin District in 1915

By Jesse A. Zook*

A review of the market price of blende, a zinc sulphide ore, and of calamine, a zinc silicate-carbonate ore, during the year 1915 reads like a fable. The year opened with a high price of $54.50 per ton for blende, and January closed with what was then thought a phenomenal rise to $67.50, or $13 in one month. February noted a further advance to $76, then a reaction to $63 the latter part of March and early April, that month closing at $68, followed with $88 in May. Here came the pyrotechnical display of the year, with advances in two weeks to $138.90, a lift of $50 in a fortnight, $70 in a month and $84 in four months. All previous records of high prices floated away as an iridescent dream, and there was no doubt in the minds of many that $200 per ton would be realized within another month. A guessing contest, originated at this time, brought out guesses up to $500 per ton. The next week it dropped to $131. No one believed it could possibly stay down, but again it dropped, this time to $112.50. Then the price was sliced off $40 more in the next three weeks, striking a low level of $72.50 per ton the third week of August, a drop of $66 in two months. That was the end of big reverses, and the price climbed to $89 the first of September, ending the month at $82.50, rose to $90 the first of October, back to $87.50, up again at the close to $93, then to $102.50 one week, $112.50 one week and $118 the latter two weeks of November. As the year drew to a close, prices receded, but the optimism of the miner's mind sees more big prices early in the new year, while present figures are quite satisfactory compared with previous years.

*Joplin, Mo.

The production of calamine assumed an importance undreamed of in past years, as prices of this mineral rose from $23 base of 40% zinc, with the opening of the year, to $40 in March and $80 in June. While the price declined through July and August, along with blende, it was less severe, at no time receding below $50, and advancing again to $80 in November.

TABLE 1. JOPLIN DISTRICT ORE SHIPMENTS, IN POUNDS

Missouri	Blende	Calamine	Lead	Values
Jasper County	436,537,130	4,540,840	62,992,000	$19,507,850
Newton County	29,728,440	32,579,160	3,819,550	1,901,680
Lawrence County	1,983,780	7,731,230	196,170	269,460
Total	468,249,350	44,851,230	67,007,720	$21,678,990
Oklahoma				
Ottawa County	56,341,060	167,280	19,435,170	2,728,720
Kansas				
Cherokee County	55,185,610	113,000	3,560,470	2,290,480
Total 1915 (*)	579,776,020	45,131,510	90,003,360	26,698,190
Total 1914	509,075,490	39,425,170	87,254,000	12,722,210
Increase	70,700,510	5,706,340	2,749,360	13,975,980

* December estimated for each county. Value increase over 100%.

For the first time in the history of the district, the production of calamine was taken over by men of big business instincts, and the Granby camp was exploited in a businesslike manner. Shipments grew under able mine prosecution from a few carloads the first of the year to upward of 30 carloads per week at the close. The demand of smelters for ores of certain grades being learned by these big producers of calamine, they withheld their ore from market during the periods of low-price level. This maintained a firm calamine price for the producer of small quantities.

TABLE 2. ORE PRICES IN JOPLIN DISTRICT

(15 Years)

Year	Zinc Ore High	Zinc Ore Average	Lead Ore High	Lead Ore Average
1901	$34.00	$24.21	$47.50	$45.99
1902	42.00	30.33	50.00	46.10
1903	42.00	33.72	60.50	54.12
1904	53.00	35.92	62.00	54.80
1905	60.00	44.88	80.00	62.12
1906	54.00	43.30	87.00	77.78
1907	53.50	43.68	88.50	68.90
1908	47.00	34.36	66.00	54.66
1909	55.00	41.08	60.50	54.56
1910	52.00	40.42	58.00	51.98
1911	51.00	39.90	64.00	56.76
1912	67.00	53.33	68.00	56.60
1913	59.00	42.26	58.00	52.52
1914	54.00	40.46	54.50	46.55
1915	138.90	77.84	80.00	54.14

TABLE 3. AVERAGE MONTHLY ORE PRICES

	Zinc Ore: Joplin base		Zinc Ore: Joplin all ores		Zinc Ore: Platteville		Lead Ore: Joplin		Lead Ore: Platteville	
	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915
	$	$	$	$	$	$	$	$	$	$
January	40.63	54.25	38.71	51.01	50.09	54.88	50.09	46.89	51.38	44.00
February	42.50	67.38	41.15	65.93	42.63	69.00	50.76	47.50	51.50	48.00
March	38.88	64.80	38.54	62.73	40.13	64.10	50.00	49.29	49.90	49.40
April	38.55	62.75	36.75	56.03	39.25	57.25	45.71	50.53	47.40	51.00
May	39.31	73.13	36.68	69.42	39.25	66.88	46.62	50.44	48.00	52.00
June	39.63	108.30	38.41	101.84	39.75	107.00	46.40	65.28	48.00	65.25
July	38.95	104.63	35.58	104.14	39.20	105.63	45.76	59.20	46.70	65.00
August	43.75	78.65	41.02	79.87	44.00	78.88	45.75	57.64	45.00	52.00
September	43.10	79.35	41.33	78.49	43.80	74.90	45.70	50.38	44.50	50.00
October	40.38	83.56	38.46	81.72	40.50	76.63	40.84	52.74	41.50	54.13
November	43.13	104.00	41.63	97.85	44.00	98.88	43.99	61.43	45.50	59.33
December	48.25	98.00	44.95	92.64	47.75	98.00	46.93	72.76	45.62	70.00
Year	41.42	81.57	39.43	78.47	42.53	79.34	46.55	55.34	48.75	55.01

Joplin base and Platteville Zinc prices are on standard ores, 60% zinc. Second Joplin price is average for all zinc ores sold.

Lead advanced in easy steps from a high price of $48 per ton the first of the year to $54.50 at the end of May. As with zinc, lead had a sky-mounting experience in

June, aëroplaning up to $80. Then, rudderless, it floundered down to $46.50 at the end of August. Efforts to find a higher landing were ineffectual. Falling so low, however, made the re-ascension easier, and an unrestricted demand elevated prices smoothly to $72 at the close of November, with the demand growing and higher prices in prospect for the new year.

The year's production was 312,450 tons of all grades of zinc ores, only 5,830 tons in excess of 1912. The year's average price of $77.84 per ton was $24.51 per ton greater than the average price in 1912. With these comparisons it is indicated that a maximum production cannot readily be increased, yet it is possible that the movement inaugurated by the high level of prices in 1915 may result in a larger increase in the 1916 yield, even though the price decline to a lower level. The production of this district is staple and cannot be spasmodically influenced, advancing slowly and receding slowly with price variations.

Metallurgically, no effort developed toward larger mills. Instead of greater capacity for heads, the increase in yield was directed to the tails, by the addition from time to time of slime tables. The disposal of the tail waste is a problem being threshed out. The level surface of this section presents a situation unusual in mining regions. Some mines installed cars for waste delivery. This proved unsatisfactory. Dewatering is now advocated, with a return to the belt-and-cup elevator, placing additional elevators on top of preceding dumps. Wet delivery is the easiest disposal of waste, but cost is against it in actual practice.

Zinc and Lead Mining in Siberia

By H. H. Knox

The Ridder Concession, about 1,600 sq.mi. in area, is held by a Russian company. The smeltery and coal mines are held by another Russian company. Both are controlled by an English company called the Irtysh Corporation, Limited. The Ridder group lies on the northern spurs of the Altai Mountains in Siberia and is connected, by about 60 mi. of railway now under construction, with the Irtysh River, which is navigable about seven months in the year.

The Ridder mine alone has developed up to date, mainly by borings, over three million tons of ore, which falls into two classes, the so-called "solid sulphides" and the "disseminated ore." In August, 1915, the general average contents of the two classes of ore were as follows:

	Long Tons	Gold, Oz.	Silver, Oz.	Cu, %	Lead, %	Zinc, %
Solid sulphides	945,000	0.47	9.7	1.5	18.1	31.2
Concentrating ore	2,229,000	0.71	1.7	0.5	3.5	6.7
Total	3,174,000	0.64	4.1	0.8	7.8	14.0

On this basis the estimated net profit in sight is £10,800,000 without reference to other mines of the group than the Ridder.

The Ridder deposit is roughly tabular in form and is approximately conformable with the inclosing strata, consisting of ancient and altered slates and tuffs and igneous sills. The solid sulphide orebody is a complete replacement of the rock and is underlaid by the disseminated ore which is a partial replacement with the hornstone gangue. The treatment of the ore at the mine involves the separation of the solid sulphides into lead and zinc concentrates and a concentration of the disseminated ore also into lead and zinc concentrates. This is accomplished by the ordinary hydraulic methods supplemented by flotation for the treatment of slimes. The products are to be shipped to the Irtysh River by rail, transported on barges down the river to the coal mines at Ekibastus, where they will be smelted to lead bullion, spelter and copper matte. The finished products will then be shipped further down the river to Omsk on the trans-Siberian railway and thence to market.

Notwithstanding the exceptional difficulties imposed by war conditions, the construction of the smelting plant is proceeding, and it is expected that the first of the zinc plant will be in operation in the spring, whereas the lead plant will be ready by the autum of 1916.

Zinc Mining in Wisconsin

By J. E. Kennedy*

War orders for spelter were reflected in the production and price of zinc ore. The net tonnage of zinc ore shipped to smelteries from the Wisconsin district, including Jo Davies County, Illinois, in the first 11 months of the year was 189,643,750 lb., an increase of 24%. The tonnage of lead ore shipped was 6,338,640 lb., an increase of 31%, while the shipment of sulphur ore, 26,534,310 lb., decreased 13%. Aside from the high price of zinc ore, the feature of the year's progress was the increase in roasting capacity, as shown in Table 2. Low-grade ore was in little demand.

TABLE 1. WISCONSIN ZINC OUTPUT, 1915

(First 11 Months)

	Net to Smelteries		Gross from Mines	
	1914	1915	1914	1915
Highland	5,097,650	3,538,060	5,097,650	3,538,060
Linden	7,570,190	12,716,810	11,612,280	13,111,660
Mifflin	6,855,120	9,202,560	40,743,220	49,619,750
Mineral Point	36,996,820	52,091,480	1,095,480	972,780
Dodgeville	1,254,290	1,109,150	1,516,270	1,109,150
Montfort	1,906,000	.....	1,906,000	.....
Platteville	12,781,940	18,735,760	5,287,560	15,098,470
Cuba City	19,640,100	31,605,060	5,370,430	3,642,600
Benton	31,740,910	36,759,190	69,563,720	119,173,940
Hazel Green	14,222,200	11,157,960	31,625,100	40,289,060
Shullsburg	2,096,070	1,130,300	19,209,800	5,712,300
Potosi	.....	651,420	.....	651,420
Galena	12,025,700	10,946,000	46,046,410	43,816,440
Totals	152,186,990	189,643,750	239,073,920	296,735,630

Shipment of Field mines from Scales Mound is credited to Benton.

Wide variation was made in the price of zinc ore. The year opened at $50 per ton base for 60% grades. The price fluctuated between $55 and $75 until June, when $100 per ton was reached, and the price was maintained at $100 and over for two months, going as high as $130 in the week ended June 19. The base declined as low as $60 during one week in August, but advanced as high as $110 in November. The highest premium price reported paid was $131.20. Prices paid for zinc ore taken under contract exceeded those paid in the open market, but were not available for publication.

A total of 57 mills and 12 roasters were in operation during the year. Fifteen concentrating mills were constructed: The Kittoe, Biddick, Lucky Six, Treganza, McMillan, Field-Thompson, Graham, Gilman, Longhenry, Cruson, M. & H., Optimo No. 3, Stoner, K. C. & M. and Blackstone. The Wisconsin Zinc Co. will shortly erect four more: The Longhorn, Birkbeck, C. A. Thompson and East End Champion. The Frontier company will equip the Hird. The Wisconsin Zinc Co. built a

*Platteville, Wis.

Skinner-type roaster at the Champion mine, New Diggings. At the year end, the Mineral Point Zinc Co. was building a Skinner roaster at Mineral Point to replace the old cylinder type, and the Field Mining and Milling Co. was assembling a Mathey roaster at Galena. The

TABLE 2. WISCONSIN ZINC-SMELTING EQUIPMENT, 1915

	Type of Roaster	Type of Machines	No. Kilns in Operation 1914	No. Kilns in Operation 1915	No. Machines in Operation 1914	No. Machines in Operation 1915	Capacity per Week in Tons of Green Ore* 1914	Capacity per Week in Tons of Green Ore* 1915
Min. Pt. Z. Co..	Mathey	Wetherill	4	5	3	4	700	1,050
National.....	Mathey	Dings	2	4	6	12	400	800
Empire†.....	Mathey	Dings	2	2	4	5	200	250
Campbell†.....	Campbell	Campbell	3	3	8	8	200	200
Linden Z. Co...	Campbell	Campbell	1	1	2	3	140	280
Indian Mound.	Mathey..	Cleveland-Knowles	1	1	1	1	125	125
Joplin†.....	Mathey	Cleveland-Knowles	..	3	..	4	....	400
Champion†....	Skinner	Cleveland-Knowles	..	1	..	6	....	800
Benton Ro. Co.	Mathey	Dings	..	2	..	3	....	200
Enterprise.....	Mathey	Dings	..	1	..	1	....	125
Climax.....	Mathey	Dings	..	1	..	1	....	125
Gr. Western...	Mathey	Cleveland-Knowles	..	1	..	1	....	125
Total.....			13	25	24	49	1,765	4,480
Increase in 1915				12		25		2,715

* Capacity varies somewhat according to grade of ore. † Wisconsin Zinc Co. plants.

most development work was done in the Benton-New Diggings territory, but many prospect drills were busy in every camp of the district.

The Wisconsin law enacted by the Legislature of 1913, assessing mineral lands for taxation upon the computed value of "ore in the ground," was amended in so far as it applied to lead and zinc deposits. By the terms of the new section the value of the land exclusive of its mineral content shall first be determined by the assessor, and to this there shall be added, in lieu of the value of such mineral content, one-fifth of the gross amount of the sales of any ore extracted at any time and sold during the preceding calendar year. The sum total is the valuation subject to the current rate of taxation, separate and distinct from the personal-property valuation of buildings, machinery and equipment, which is likewise subject to the current rate of taxation.

Cadmium

The price for cadmium during 1915 was $1.25@1.50 per lb. This metal is used chiefly by the manufacturers of silverware. It has no military use, at least none of consequence, and its history in 1915 was therefore quite different from that of the other metals. Indeed, the consumption of it was less than it was in 1914.

The New York Tin Market

The New York tin market during 1915 was purely a local market, limited by consumptive demand and at times during the year dwindling to a very small affair. Its course depended considerably upon the London market.

In January the market opened rather weak with business slow, and an advance in London, mainly based on the spot position, failed to stir buyers here. Later in the month the London prices became firmer, but consumers here paid very little attention and purchases were small. Business continued light through the month. In February there was a rise in prices of something like 3c. per lb., which was due principally to freight congestion on the docks in London and difficulty in getting freight room for Atlantic shipments, which caused some expectation of scarcity here. Business later subsided into dullness, and buying was only for necessary requirements.

In March the market continued dull, but there was an advance in prices, owing chiefly to the difficulty of getting supplies. Later in the month the situation developed into a shortage of spot supply here, and although there was no panic, prices rose to what proved to be the highest level of the year, the average for March in New York being 48.426c. The actual shortage was increased in its effect upon the market by the British government prohibition of the exportation of Straits tin to other than British ports. Business at the highest prices was very small. In April the market was rather erratic, prices remaining high, but fluctuating from day to day on small business.

In May the market was quiet, but there was a fair turnover of metal at prices rather lower than those that prevailed in April. The importation from Great Britain under consular supervision had been reduced to a workable form, and little difficulty was found. Later in the month some upward fluctuation was caused by the sinking of the "Lusitania." The effect of the rise, however,

MONTHLY AVERAGE PRICES OF TIN IN 1913, 1914, AND 1915

Month	New York 1913	New York 1914	New York 1915	London 1913	London 1914	London 1915
January.....	50.298	37.779	34.260	238.273	171.905	156.550
February.....	48.766	39.830	37.415	220.140	181.556	176.925
March.....	46.832	38.038	48.426	213.615	173.619	180.141
April.....	49.115	36.154	47.884	224.159	163.963	166.225
May.....	49.038	33.360	38.790	224.143	150.702	162.675
June.....	44.820	30.577	40.288	207.208	138.321	167.636
July.....	40.260	31.707	37.423	183.511	142.517	167.080
August.....	41.582	*	34.389	188.731	*	151.440
September.....	42.410	32.675	33.125	193.074	*	152.625
October.....	40.462	30.284	33.080	184.837	*	151.554
November.....	39.810	33.304	39.224	180.869	139.391	167.670
December.....	37.635	33.601	38.779	171.786	147.102	167.000
Av. year.....	44.252	.....	38.590	206.279	.....	163.960

New York in cents per pound; London in pounds sterling per long ton. * No quotations.

was to quiet business down and make sales smaller than they had been. At the beginning of June business was moderate with only small fluctuations, but toward the middle of the month demand was active and strong and considerable sales were made, after which the market quieted down and the volume of business became small. The quantity of tin sold during the month, or rather, it should be said, during its active season, was considerable and the average price for the month was over 40c.

In July the market was very quiet, consumers being for the most part supplied with metal, while there were good arrivals and a sufficient supply, sellers rather pressing metal for sale. August showed no special demand, and prices were rather weak. Dealings in spot were slow, the demand for futures being rather better. The low rates for sterling exchange seriously affected the market.

Throughout September the market continued dull, with sales only of material that was needed by consumers and a general absence of fluctuations. About the beginning of October rumors began to be circulated that the government of the Federated Malay States intended to put an export duty on tin. These reports were cabled over to Europe, where dealers apparently had not heard them, and this was followed by a sharp rise in price. The rumors were subsequently contradicted. Later in the month the market was steady, being supported by a fair buying by consumers.

In November the price rose again under the influence of rather heavy buying, which seemed to be due chiefly to the improvement in different kinds of business where tin is required. About the middle of the month there was a sharp advance caused by the increased demand and by rumors concerning the stoppage of British vessels in the Suez Canal. The discovery that these were rumors only

and that the canal had not been interfered with caused a recession, and the price dropped from the high point reached during the month. Toward the end of the month business was light and the market declined. These conditions extended into December, but only a fair business was done in spot on the decline. Subsequently the market rose very sharply on news that the British government intended to curtail exports until a safe working stock could be accumulated. When it was learned that the government idea of this safe stock was 4,000 tons, of which 3,000 tons was already on hand, the price dropped again, and for the remainder of the month business was on a moderate scale, mainly for early consumption.

The fluctuations in December were a fair indication of the general course of the market, which on the whole was light and easily affected by current rumors or only moderate buying.

Tin Smelting in United States

The American Smelting and Refining Co. has about completed an addition to its Perth Amboy works, which consists of a new plant for the smelting of tin ores and concentrates and the electrolytic refining of tin.

The United States imports about 45,000 tons of tin yearly, and of this about 90% is Straits tin, which is largely consumed in the manufacture of tinplate, for which purpose a practically pure tin is required. At present this can be obtained in quantity only from the Straits Settlements. The remainder of our importations is mostly from English smelters and is used for alloys, principally solder.

TIN PRODUCTION AND CONSUMPTION
(In Long Tons)

	1913	1914	1915
Exports, Straits and Malay Peninsula	62,242	61,986	66,760
Exports, Australian	3,253	1,771	2,275
Banka and Billiton sales	17,142	10,975	15,093
Chinese exports and production*	8,200	8,255	7,097
Bolivian exports*	22,719	24,844	18,800
South African production*	1,900	2,276	2,158
Nigerian production*	.....	1,962	1,899
Cornwall production*	4,900	4,500	4,000
Total	120,356	116,569	118,082
U. S. imports and consumption	45,900	42,995	49,480
Great Britain, imports and consumption	28,736	30,531	39,937
Holland, imports	16,573	15,810	7,625
Other Europe, imports	21,250	18,633	11,550
Australian consumption	1,000	1,050	1,100
China and India consumption	6,500	6,400	6,650
Totals	119,959	115,419	116,342
Visible stocks, Dec. 1	16,045	13,432	14,535

*Not in "Statistics."

The Straits Settlements imposes a protective export duty on tin ores, thus compelling the reduction to metallic form in the country in which it is produced. Several years ago a tin smeltery was built at Bayonne, N. J., but about the time it was completed this duty was imposed, so the works was never operated.

Apart from the Straits Settlements, Bolivia is the largest producer of tin ore, but the Bolivian tin contains impurities, which with the established methods of smelting do not permit the production of a tin suitable for tinplate, the principal use for tin in this country. The plant now being built at Perth Amboy is not only to smelt the impure ores from Bolivia and other countries, but also is to refine the product by an electrolytic process.

Recent analysis of this electrolytic tin made in England by the most experienced chemists in the tin trade shows it to run 99.98% pure, while the base metal from which this was produced contained only 93% tin. The impurities consist of lead, antimony and copper as well as small amounts of many other metals. Tests have also been made of this electrolytic tin by tin-plate manufacturers and it is pronounced equal in every respect to the best Straits tin.

The Perth Amboy plant is, of course, to a certain extent an experiment. Probably some difficulties will have to be overcome, but the indications are that it will be a success, as the work is in the hands of expert men, both in the smelting of tin ores and the electrolytic treatment of metals. One patent has recently been issued to the company for electrolytic refining of tin, and others are pending.

Tin in Bolivia

Following the depression of 1914, a revival came in the first part of 1915, when it was found that the export of concentrates could be resumed and that there was reëstablished a regular market for tin ore in England. Production was soon stimulated by improvement in prices, but toward the middle of the year exports declined, owing to the large stock of tin ore accumulated in Liverpool, decrease in the price for the metal and difficulty in selling low-grade concentrates. There was a change for the better in October, and in the last quarter of 1915 all the mines were working at full capacity. The exportation from Bolivia in 1915 is estimated at 42,000 metric tons of concentrates, averaging 60% tin, compared with 37,260 tons in 1914 and 44,600 tons in 1913.

Probably the tin production of Bolivia will increase during the five years next to come, owing to improvement in mining and milling practice and better railway facilities. However, it is considered doubtful whether the production of Bolivia will exceed 60,000 tons of concentrates per annum in the near future. No new tin mines of importance are being opened.

Favorable conditions for tin mining in Bolivia in 1915 were the low exchange rate of Bolivian currency and the relatively low wages for miners, there having been a reduction during the crisis of 1914. Unfavorable factors were the elimination of the competition of the German smelters and the closing of several small British and French smelteries. The largest smelters in Great Britain continue to buy tin concentrates, but selected the best qualities on the market and raised their returning charge from £10 to £16 per ton of 60% concentrates, retaining the usual sliding scale of 5s. per unit. Ore of lower grade than 65% tin or with undesirable impurities was practically unsalable. The entry of the American Smelting and Refining Co. into the market, however, helped matters a good deal. An unfavorable factor in prospect is the danger that the Bolivian government may put an export tax on tin ore.

Quicksilver

The production of quicksilver in the United States in 1915, according to the United States Geological Survey, was 20,681 flasks, compared with 16,548 flasks in 1914. The output of California was 13,916 flasks in 1915, compared with 11,303 flasks in 1914. The chief producers in California in 1915 were the New Idria mines, the New Guadalupe and New Almaden, the Oceanic, the St. Johns and the Oat Hill. The remainder of the American production was derived from Nevada and Texas.

In Nevada active prospecting and development continued in 1915, and the total output increased. A 50-ton

furnace was under construction at the Goldbanks, during the year. In Nye County the Mercury mine, near Ione, was shut down from February to July, but made a considerable output the latter half of the year. The Nevada Cinnabar Co. reported an active year and largely increased yield. The Telluride group, near **Beatty,** was hampered by litigation, but made a small output from concentrates treated in a retort.

The exports of quicksilver from the United States in 1915 were about 3,300 flasks, compared with 1,446 flasks in 1914. The imports were about 5,200 flasks, compared with 8,198 flasks in 1914. The Italian embargo on quicksilver prevented the continuance of imports from that quarter.

AVERAGE MONTHLY PRICE OF QUICKSILVER

(Per Flask of 75 Lb.)

	1914			1915		
Month	New York	San Francisco	London	New York	San Francisco	London
January....	$38.75	$38.63	£7.50	$51.60	$50.80	£11.35
February...	39.00	38.50	7.50	59.38	58.00	12.28
March.....	38.60	38.30	7.30	73.13	62.16	12.50
April.....	38.00	38.00	7.00	71.50	64.31	12.44
May.....	37.90	37.60	7.00	77.20	67.50	11.80
June.....	38.00	37.13	7.00	95.63	88.13	15.13
July.....	36.75	36.50	6.75	95.50	92.50	17.94
August.....	83.00	90.00	....	92.90	89.25	18.15
September..	74.38	74.00	....	89.50	88.00	16.50
October....	53.75	53.50	....	94.70	90.80	15.90
November..	50.30	51.00	....	108.13	102.00	16.38
December..	51.25	51.00	....	135.00	121.25	16.63
Year.....	$48.31	$48.68	.....	$87.01	$81.23	£14.75

California Quicksilver

By Murray Innes*

California quicksilver production in 1915 is estimated at 13,916 flasks, an increase of 2,645 flasks over 1914. The principal producers were again the New Idria, Oceanic, New Almaden and Guadalupe. The new Idria, in San Benito County, produced 6,200 flasks, compared with 6,600 flasks in 1914, while the Oceanic, New Almaden and Guadalupe were, as in 1914, the only other producers credited with more than 1,000 flasks each. In addition there was, as in recent years, a production of about 2,500 flasks from a dozen or more other ventures, items regarding which have appeared in the *Journal* from time to time during the year. There has been much talk of reopening old mines, but so far this has not resulted in production or new equipment of importance.

The average returns to the producer in 1915 were more than double those of 1914, and therefore the small increase in production is surprising. The New Idria, for example, realized, according to its annual report of 1914, an average of $41 per flask, while returns for 1915 will be in the neighborhood of $85 per flask. The market price advanced from $50 last January to $150 in December, 1915, the market being well reflected in the *Journal.*

Why has the quicksilver production in California steadily declined from an annual average of 60,000 flasks for the 10 years ending with 1885 to 13,000 flasks in the last two years, and why has the state's production shown no greater increase in 1915, notwithstanding the highest market price in 40 years? Exhaustion of the high-grade surface deposits answers the question in part only. One added reason is that probably nine-tenths of all the quicksilver deposits lie in the Coast Range and on lands that have, during the last 30 years, gradually been patented as agricultural and are no longer open for mineral location under our present mining laws. As a rule the owners of these lands know nothing of mining or lack the means to develop and equip. The prospector has little inducement to develop ground that he cannot locate, and as a result the mineral remains undiscovered. In the meanwhile, after several lean years the surviving producers are more hopeful.

While the California production has steadily decreased, even in the last 10 years, from 30,000 to 13,000 flasks per year, it is instructive to note that the production in Austria has, during the same period, increased from 17,000 to 27,000 flasks; that the production of the mines in Italy (owned by German and Austrian capital) has increased from 11,000 to 30,000 flasks—an exact reversal of our progress; also that the Spanish production (controlled in England) has increased from 25,000 to 44,000 flasks.

Prior to 1895 our import tariff on quicksilver was 10c. per lb., and from 1895 to 1913 this duty was 7c. per lb. The present Administration then saw fit to place the duty on an *ad valorem* basis of 10%, and for 1913 the duty amounted to 4.8c. and for 1914 to 4.6c. per lb. The net result was that the producers were, market-wise, placed face to face with the cheapest labor in Europe and requested to compete. The imports on foreign quicksilver increased from 84 lb. in 1906 to 614,869 lb. in 1914 and ceased only when its export was prohibited by England and her allies.

Quicksilver mining was once an important industry in California and may be so again if the investor is given reasonable assurance of a tariff that will permit him to operate in fair competition with European producers after the embargo is lifted and conditions are again normal. A reasonable import duty to compensate for the different labor conditions would probably double the California production in a year or two. This production may not be of great importance outside of California, provided the United States can always be sure of adequate supplies for Government uses in times of emergency. However, for the time being, we are cut off from foreign supplies, and the market indicates that it might be a difficult matter for even the Government to accumulate any considerable reserve stock for the manufacture of fulminate, antiseptics, etc. The production, not only of California but of North America, is now far short of the ordinary peace requirements of the United States. These requirements are now in the neighborhood of 25,000 flasks per year and seem to be increasing.

*Oceanic Quicksilver Mine, Cambria, Calif.

Texas Quicksilver in 1915

The Chisos Mining Co., which is the only operator in the Terlingua district, has closed a record-breaking year with a production of 1,200 flasks of quicksilver for the months of November and December; 150 men are employed. Its capacity will soon be greatly increased by supplementing its 18-ton shaft furnace with a rotary furnace capable of treating double that amount. This will place at the company's disposal a large quantity of ore of such low grade that it could not have geen previously treated at a profit. Wayne Cartledge is general manager.

The Big Bend mine is being reopened by W. D. Burcham. It has been unwatered and one year's supply of ore blocked out. The mine started its 50-ton furnace on Jan. 1, 1916, and is expected to produce 300 flasks of quicksilver per month.

Iron and Steel

By Frederick Hobart

The year 1915 will be remembered in the history of the iron trade by the extraordinary changes which took place during its course and by the remarkable contrast between its opening and closing. These changes were due in part to the conditions prevailing in Europe resulting in a tremendous growth of export trade; but in large part also to a growth in domestic business and the active development of home consumption under the influence of increasing business confidence and the abundance of money due to extraordinary crops and to the betterment of the banking system under the new law.

The year 1914 closed with some anticipations of better business, but with no immediate signs of any great improvement over the depressed conditions which then prevailed. Production of pig iron was at the rate of only about 22,000,000 tons a year, a low point as compared with previous years, although it would have been considered high only a few years ago. For the first half of the year this rate increased gradually but slowly and the official report showed little gain over 1914. From July on, however, production of all kinds of finished materials began to increase, and month by month this increase was greater in proportion, until the year closed with an output of pig iron at the rate of 38,000,000 tons a year, the highest ever reached in our industrial history and with a production of finished steel which cannot be very far from the same tonnage.

The first impetus to the trade was given by the placing of large orders, mainly for finished steel in various forms, for export to Europe. The countries engaged in war turned to the United States for assistance in supplying munitions and found our manufacturers ready to respond. This class of business grew to large proportions as the year went on, but it was soon found that foreign demand was being supplemented by a heavy call from domestic consumers. Under the joint influence of the foreign and domestic demand the year closed with our mills and furnaces working closely up to their full capacity and carrying a volume of contracts which seemed to assure them full work during at least the first half of 1916. Many of them, indeed, are indisposed to accept business for the second half, fearing that they will be unable to carry out their contracts. The domestic business comes from all branches of the trade. The railroads, which had been backward for over a year, are increasing their calls for rails and other material. New building construction is already on a large scale and promises to be much greater in the new year, while shipbuilding is demanding more material than ever before. Upon the whole, it may be said that few years have opened with such prospects for activity as the one that has just begun. Toward the close of the year deliveries of material were delayed by railroad congestion, and exports by the lack of ocean steamers.

Iron Ore

The production and consumption of iron ore in the United States, which in 1914 showed a material decrease from previous years, recovered this year almost to the high figures of 1913. Approximate figures are given in Table 1, in which the exports and imports are estimated for the months of November and December. In this table no account has been taken of changes in the stocks of iron ore on hand. The difference in the visible stocks was not large in comparison with the total, and there are no data upon which the stocks in furnace yards can be estimated with any degree of correctness. There is good reason to believe, however, that those stocks are low, and this belief is supported by the urgency with which deliveries of ore are called for.

TABLE 1. IRON-ORE PRODUCTION AND CONSUMPTION

(In Long Tons)

	1913	1914	1915
Lake Superior shipments	49,947,116	33,721,897	47,143,804
Southern ore mined	7,950,000	6,175,000	7,825,000
Eastern and other local ores	3,950,000	3,015,000	3,875,000
Total production	61,847,116	42,911,897	58,843,804
Imports	2,594,876	1,455,000	1,214,098
Total supplies	64,441,992	44,366,897	60,057,902
Exports	1,042,151	660,000	635,500
Approximate consumption	63,399,841	43,706,897	59,422,402

Lake Superior Iron Ore

As for 10 years past Lake Superior iron ore has supplied the material from which almost 80% of our pig iron is made. The statistics of shipments and distribution of that ore are carefully kept, and the volume of the trade can be accurately reported. The total shipments from the iron ranges of Michigan and Minnesota, arranged by ports, for the season year ended Dec. 1, are given by the *Marine Review* of Cleveland as in Table 2. The total shipments there shown represent a great increase over those of 1914, but did not quite reach the level of the previous year. Of these shipments during the season, a total of 37,332,428 tons was delivered at Lake Erie ports, the balance going to ports on Lake Michigan, chiefly South Chicago and Gary, with a small quantity to charcoal furnaces in Wisconsin and Michigan. The total shipments from the Lake Erie docks for the shipping season were 34,323,316 tons, and the ore remaining on docks on Dec. 1 was 9,797,980 tons. The rate at which shipments are now being made is such that in all probability the stocks on docks when the shipping season opens in the spring will be the lightest reported for a number of years.

TABLE 2. LAKE IRON-ORE SHIPMENTS

	1914		1915	
	Tons	Per Cent.	Tons	Per Cent.
Escanaba	3,664,451	11.5	5,693,663	12.3
Marquette	1,755,726	5.5	3,099,589	6.7
Ashland	3,363,419	10.5	5,146,772	11.1
Two Harbors	5,610,262	17.5	8,367,381	18.1
Superior	11,309,748	35.3	8,633,980	18.4
Duluth	6,318,291	19.7	15,437,419	33.4
Total water	32,021,897	100.0	46,318,804	100.0
Rail shipments	700,000	....	825,000	....
Total	32,721,897	....	47,143,804	....

The rail shipments given in Table 2 are estimated, the full reports not having been completed as yet. The shipments for the season have not been apportioned by ranges so far, but taking the port figures it is apparent that between 69 and 70% of the shipments were from the Mesabi and Vermilion ranges in Minnesota, with about 30% from the old ranges in Michigan and Wisconsin. These ranges were actively worked with some new developments and showed heavy increases in shipments, but the great mines of the Mesabi kept up their full activity.

All preparations are being made at the Lake Superior mines for great shipments in the coming season, and there

is no doubt that very high figures will be reached. Preparations are also being made for a very large ore movement on the Lakes, and a peculiar situation has developed in the vessel market. The large companies have secured by charter or purchase nearly all the available boats outside of their own fleets for carrying ore, and there will be no chance for outside shippers to secure wild tonnage.

A peculiar feature of the Lake trade in 1915 is that the season opened light, and it was not until July that ore shipments began to be pushed. The consequence was that the greater part of the shipments were handled in four months of the season, and the results showed what the present Lake fleet can do, even without any additions to its capacity. The new vessels built during the year did not do much more than to fill up the vacancies made by storm losses and depreciation. A number of new boats are now under contract, but very few of them will be ready for service until toward the close of the coming season.

In the East the increasing demand for ore, as the season went on, resulted in active work in the ore districts of eastern Pennsylvania, New Jersey, the Hudson River and Lake Champlain. The importation of foreign ores was strictly limited by the scarcity of ocean tonnage and the high prices charged for freights. Even from Cuba it was at times difficult to get vessels for transportation. Shipments from Newfoundland and Labrador show a heavy decrease, as do those from Spain and Sweden. A beginning was made in the shipment of iron ore from Chile, but this was hindered during the closing months of the year by the delays at the Panama Canal.

The prices agreed upon for Lake iron ore for the season of 1916 were advanced about 70c. per ton over those of 1915. The new prices delivered at Lake Erie ports are: Old Range bessemer, $4.45; Mesabi bessemer, $4.20; Old Range nonbessemer, $3.70; Mesabi nonbessemer, $3.55. Prices of Eastern ores are showing a corresponding increase, contracts for 1916 delivery being made at 8¼@9c. per unit of iron as against 6¾@7½c. a year ago. These prices are for ore delivered at furnaces in eastern Pennsylvania.

Pig Iron

The production of pig iron by half-years for four years past is given in Table 3, the first half of 1915 being the corrected figures of the Iron and Steel Institute, while

TABLE 3. PIG-IRON PRODUCTION BY HALF-YEARS

	1912	1913	1914	1915
First half	14,072,274	16,488,602	12,536,094	12,233,791
Second half	15,654,873	14,477,699	10,720,000	17,737,400
Year	29,727,147	30,966,301	23,256,301	29,971,191

the second half is estimated on the basis of the monthly statements of the furnaces. The official figures, when published, may show a small deviation, but it will probably be in the nature of an increase rather than a decrease. The total shows an increase of 6,639,000 tons over 1914 and is only 995,000 tons below that of 1913. It is greater than that of any other preceding year in the history of the trade. This is more remarkable from the fact already stated that production in the early part of the year was at a low point. As will be seen from the table, the make of pig iron in the first half of the year was only 40.8%, while that of the second half was 59.2% of the total.

The ore consumed in making this iron averaged 1.98 tons to the ton of pig iron. About 900,000 tons of iron ore is used yearly in openhearth furnaces and rolling mills. This quantity, however, is more than offset by the quantity of mill cinder, slag and other miscellaneous materials used in the blast furnaces. The fuel used in making this iron was approximately 36,500,000 tons of coke, 48,500 tons of raw bituminous coal, 76,500 tons of anthracite and 35,000,000 bu. of charcoal. The limestone and dolomite used for flux was approximately 14,865,000

TABLE 4. PIG-IRON PRODUCTION FOR 15 YEARS

1901	15,878,354	1906	25,307,391	1911	23,649,547
1902	17,821,307	1907	25,781,381	1912	29,726,937
1903	18,009,252	1908	15,936,918	1913	30,966,152
1904	16,497,003	1909	25,795,471	1914	23,332,244
1905	22,992,380	1910	27,303,567	1915	29,971,191

long tons. Table 4 shows the pig-iron production for 12 years past in long tons and illustrates the increase in iron-making capacity during that period, as well as the increase in demand. Additions to blast-furnace capacity during the past two years have been comparatively small, but more are planned for the near future.

Assuming that the proportions of the various classes of pig iron were approximately the same in the second half as in the first half of 1915, the production for the year, classified according to intended uses, is given in Table 5,

TABLE 5. PIG-IRON PRODUCTION BY GRADES

	1914		1915	
	Tons	Per Cent.	Tons	Per Cent.
Basic	9,670,687	41.5	12,886,696	43.0
Bessemer	7,859,127	33.7	10,375,727	34.6
Foundry	5,205,025	22.3	6,086,579	20.3
Forge, etc	412,387	1.7	389,979	1.3
Spiegel and ferro	185,118	0.8	232,210	0.8
Total	23,332,344	100.0	29,971,191	100.0

in which low phosphorus is included with bessemer pig, ferrosilicon with foundry and a small tonnage of miscellaneous with forge pig. The consumption of pig iron for two years past is shown in Table 6, exports and imports for the last two months being estimated. The reduction in stocks is also estimated and is probably stated

TABLE 6. CONSUMPTION OF PIG-IRON

	1913	1914	1915
Production	30,966,152	22,976,856	29,971,191
Imports	156,435	138,903	81,190
Decrease in stocks	.....	.....	850,000
Total supply	31,122,587	23,115,759	30,902,381
Exports	277,648	114,423	209,240
Increase in stocks	500,000	750,000	.....
Total deductions	777,648	864,423	209,240
Approximate consumption	30,344,939	22,251,336	30,693,141

conservatively. There is no doubt that the large unsold stocks which were carried early in the year had practically disappeared at its close. The great increase in production was made by the furnaces owned by the steel companies. The merchant furnaces are very largely employed in supplying the foundry trade, and in 1915, as has often been the case in previous years, the foundry business was the last to recover from its dullness, the urgent demand being chiefly for finished steel in various forms and for steel in billets and blooms.

Steel

There are no definite figures available at this early date for the production of steel, but its estimated amount was about 29,500,000 tons, the total being very nearly equal to that of pig iron. The demand for finished steel required the use of very considerable proportions of scrap in the openhearth furnaces. The completed returns will probably show considerable variations from previous years in the classes of steel made. The foreign orders for munitions required the making of a large proportion of steel bars and rounds of large size and other unusual forms. The tonnage of rails was rather lower than usual, although it promises to be heavy for the coming year. Plates and

structural material will probably constitute about the usual proportion of finished steel.

The more important new construction of the year was that carried out by the Bethlehem Steel Co. and by the Minnesota Steel Co. at Duluth, a subsidiary of the Steel Corporation. Not much new work was done during the first half of the year, and comparatively little during the second half, although a number of works are putting in additional openhearth furnaces. Much new work is planned for the coming year.

Several large consolidations have been talked about during the year, but for the most part, have not reached the stage of completion. The Midvale Steel and Ordnance Co. is a notable instance, which has been completed. In the last quarter of the year an important change in the ownership of the great Cambria Steel Corporation occurred, owing to the sale of the large interest in the stock which has been held by the Pennsylvania R.R. The latest plan is the consolidation of this company with the Lackawanna Steel Co., with its large works at Buffalo and with the Youngstown Sheet and Tube Co., which is an important manufacturer of finished material. The ownership of the Pennsylvania Steel Co. has likewise changed, but nothing definite has so far been done with regard to its consolidation or extension. An important consolidation of Eastern blast furnaces has been arranged for, which includes the Thomas Iron Co., the Wharton Iron and Steel Co. and the Empire Iron and Steel Co. These concerns own a number of blast furnaces, with extensive interests in ore and coal mines. When completed, the consolidation will be the largest producer of merchant iron in the country. The Thomas Iron Co. is the oldest producer of merchant iron in the United States, as well as the largest.

The United States Steel Corporation has followed the general course of the trade. Its business and earnings have showed large recovery, but its proportion of the total was probably less than in 1914. Dividends on the common stock have not been resumed, although the third and fourth quarters showed a very considerable increase in earnings.

Foreign Countries

Great Britain has furnished no statement for any part of the year. The indications are, however, that the production of iron and steel was about the same as in 1914.

The foreign trade of Great Britain in iron and steel for 11 months ended Nov. 30 is valued by the Board of Trade returns as follows:

	Exports	Imports	Excess
Iron and steel.....	£36,909,103	£9,870,138	Exp. £27,038,965
Hardware, machinery, etc.....	26,917,658	13,612,477	Exp. 13,305,181
Totals	£63,826,761	£23,482,615	Exp. £40,344,146
Totals, 1914.....	85,674,792	22,635,453	Exp. 63,039,339

Actual quantities of iron and steel exported were 3,678,831 tons in 1914 and 2,944,838 tons in 1915; imported, 1,557,243 tons in 1914 and 1,090,400 tons this year.

For Belgium and France, owing to the disorganization wrought by the war, no statistics are available. Germany has kept its production up to about two-thirds of a normal year, the make of pig iron for the 10 months ended Oct. 31 having been 9,741,871 tons and that of steel 10,832,039 metric tons.

The production of Canada, like our own, showed a large increase over 1914, much of this being due to work on munitions of war.

In Australia a notable event was the completion of the first important blast furnace and steel works in the country, built by the Broken Hill Proprietary Co. and successfully started in September.

Pittsburgh Iron and Steel Markets

By B. E. V. Luty*

In no year has the steel industry ever made such a remarkable record as in 1915. The high prices reached in the year find their parallel in the general level attained in 1906 and 1907, but the prices then were reached by a slow and steady movement. In 1902 prices were somewhat higher than prevailed at the close of 1915, but that price level also was attained by relatively slow stages. In 1899 prices rose as rapidly as in 1915, and reached a materially higher level, but there was the very important difference between 1899 and 1915 that substantially full production occurred for almost two years preceding. During 1915, on the other hand, the rate of pig-iron production more than doubled and the rate of steel production fully tripled. Pig-iron prices scored an average advance of more than $5 a ton. Bessemer billets advanced about $12 a ton, while finished steel products generally scored an average advance of somewhat more than $12 a ton; and if the premium prices paid toward the close of the year for early deliveries be taken into account, the rise in steel products was still greater.

Action in the steel market was so rapid and at times so violent that it was impossible to discern clearly the underlying forces at work, and at the close of the year it was evident that the judgment pronounced earlier in the year, that the war demand for steel was chiefly responsible for the activity, was largely at fault. Perhaps the truer perspective obtainable a year or two hence may alter the views obtaining at the close of the year as to the fundamental factors causing such remarkable developments.

To trace briefly, as a prelude to an attempt at analysis of causes and real conditions, the course of the iron and steel markets during the year, it may be said that in December, 1914, pig-iron prices were the lowest since 1904 and finished-steel prices, by a small margin, the lowest since the fore part of 1899. Pig-iron production was at a rate slightly less than one-half the capacity and steel production at a rate not more than one-third the capacity. During the first half of the year pig-iron fluctuated narrowly, not definitely advancing until July, while the rise in the second half of the year amounted to more than $5 a ton. Steel prices advanced slightly during the first half of the year, by about $2 a ton, then beginning to rise more rapidly, while the advances in the last quarter of the year may be described as really

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violent, no such rate of advance having prevailed, in a period of three months, since the memorable year 1899. Production of pig iron increased moderately during the first half of the year, while steel production increased more rapidly. In the third quarter production of both pig iron and steel increased steadily until a rate fully equal to capacity was reached. The year had opened with accumulations of pig iron at steel works, the consumption of the stocks accounting for the difference between the rates of pig-iron and steel production increase respectively.

Demand for pig iron and steel, as expressed in actual market purchases, is not always in exact relation to actual consumption requirements. In the case of steel products, stocks, if carried at all, are carried by buyers rather than by producers. According to the buyers' expectations as to the future, these stocks are decreased or increased, and thus as a rule the steel market is either languishing or definitely advancing. Stocks in buyers' hands had been liquidated to an extent in 1913, but in 1914 the liquidation was made complete. The situation was ripe for a buying movement, but the trade did not expect an important buying movement as long as the war lasted. It had seen five months of war, during which no good things developed. Prices had reached such a low ebb in December, 1914, however, that some buying was induced, encouraged by the improved financial conditions produced by the establishment of the new banking system, Nov. 16, 1914, and the large balances in foreign trade that were beginning to pile up in favor of the United States.

The steel mills were quick to make the most of the situation and began advancing prices, frequently setting a date upon which they would establish an advance. Buying was thereby encouraged. Orders for war material were placed in constantly increasing volume. At first the reports of these orders were thought to be greatly exaggerated, but by the middle of the year it had to be admitted that a very large volume of trade had come to the American steel industry by reason of the war. The steel mills were then operating at about 90% of capacity. The opinion of the majority of buyers was that the entire backbone of the steel market was the war demand, and in consequence they did not have much confidence in the situation. In July and August, however, they came to realize that even though the demand were merely a war demand, it might possibly fill the mills and make it difficult to obtain deliveries, particularly since very fancy prices were freely paid for war material. They began to specify very freely on their contracts, and to seek contracts for periods farther ahead, whereby in September the mills began to fall behind in deliveries. The market then became intensely excited, and there was a wild scramble for material. Many buyers were securing deliveries perfectly satisfactory, but some were not and their cases attracted attention, while the cases in which deliveries were satisfactory did not. Some fresh consumptive demand arose, particularly on the part of the railroads, and this demand coming to mills already oversold necessarily made the situation from the mill viewpoint extremely strong.

The view entertained quite generally in June, that almost the sole support of the steel market was the war demand, may possibly have been a correct view at the time, but it certainly was not correct as to conditions obtaining in October. Steel production increased until September or October, when the capacity rate was increased, but steel exports were heaviest in August, decreasing in September and still further in October. The October exports of tonnage products as reported by the Government, plus a liberal estimate of the steel made for indirect exports, including shells, machinery, railroad rolling stock, etc., did not account for as much as 25% of the steel-mill output in that month, so that domestic buyers were taking more than 75% of the output for eventual domestic consumption, and all exports, direct and indirect, to the belligerents and to neutral countries amounted to less than 25%. It did not follow, however, that all the material taken by domestic buyers was for immediate consumption. As current prices were high and most buyers were provided with relatively low-priced contracts, it was natural for them to specify freely. The year closed with some material in stock and some material on order that was not immediately required. On the other hand, there appeared to be a large unsatisfied consuming demand. There was reason to believe that the latter influence would easily preponderate, but the market had advanced too rapidly to permit it to be regarded as certain that domestic consumption would be maintained at a full rate under high prices.

Pig-iron production in the first half of 1915 was 12,233,791 gross tons, and production in the second half can be estimated at 17,700,000 tons, making 29,900,000 tons for the year. At the close of the year pig iron was being produced at the rate of 38,000,000 tons a year, steel ingots at about 38,000,000 tons, steel castings at about 1,000,000 tons and finished rolled steel at fully 28,000,000 tons.

AVERAGE PRICES AT PITTSBURGH, 1915

	Pig Iron					Steel				Nails	
	Bessemer	Basic	No. 2 Foundry	Ferro-manganese	Bessemer Billets	Beams	Plates	Bars	Black Sheets No. 28	Wire per Keg	Cut per Keg
January	$14.49	$13.45	$13.70	$70.30	$19.25	1.10c.	1.10c.	1.10c.	1.80c.	1.54c.	1.58c.
February	14.55	13.45	13.70	70.30	19.25	1.10	1.10	1.10	1.80	1.58	1.55
March	14.55	13.45	13.70	80.30	19.30	1.15	1.15	1.15	1.80	1.60	1.55
April	14.55	13.45	13.70	80.30	19.50	1.20	1.20	1.20	1.80	1.57	1.55
May	14.61	13.60	13.70	93.30	19.50	1.20	1.17	1.20	1.80	1.55	1.55
June	14.70	13.67	13.65	102.30	20.00	1.20	1.15	1.20	1.76	1.55	1.55
July	14.94	13.91	13.67	102.30	21.40	1.25	1.22	1.27	1.74	1.58	1.55
August	16.01	15.31	14.66	102.30	23.50	1.30	1.26	1.30	1.85	1.61	1.55
September	16.86	15.95	15.45	109.80	25.50	1.33	1.33	1.35	1.91	1.69	1.58
October	16.95	15.96	15.53	107.30	26.00	1.44	1.42	1.43	2.03	1.78	1.65
November	17.57	16.47	16.77	102.30	26.20	1.63	1.63	1.63	2.30	2.87	1.72
December	19.95	18.95	18.95	102.30	30.00	1.75	1.75	1.75	2.50	2.00	1.87
Year	$15.81	$14.80	$14.77	$93.59	$22.45	1.30	1.20	1.31	1.92	1.66	1.60
Year 1914	14.89	13.76	13.89	57.79	20.03	1.16	1.14	1.15	1.89	1.57	1.57

Prices of pig iron, ferromanganese and billets are per ton, 2,240 lb.; of steel products, per lb.; of nails, per 100 lb., base.

Graphite Exports from Ceylon decreased from 63,936,684 lb. in 1913 to 31,871,944 lb. in 1914. The chief causes for the loss were the embargo placed on exports from Ceylon and the competition of Madagascar graphite.

Chronology of Mining for 1915

JANUARY

Jan. 7—Federal District Court at San Francisco declared Arizona's alien law to be unconstitutional.—German Zinkhüttenverband dissolved owing to closure of some of the Belgian works.

Jan. 11—Strike started in Miami and Globe.

Jan. 12—The Zinkhüttenvereinigung organized to take the place of the old Zinkhüttenverband.

Jan. 13—Copper Producers' Association dissolved.

Jan. 24—Strike in Globe-Miami district settled; work resumed at increase in wages.

Jan. 26—United States Steel Corporation passed dividend on common stock.

Jan. 27—Announcement of raise in wage scale at Bisbee following higher price of copper.

FEBRUARY

Feb. 1—Bristol mine, Crystal Falls, Mich., resumed operations.—Inland Steel Co. assumed control of Armour No. 1 and No. 2 mines on Cuyuna Range.

Feb. 6—Serious cave in inclined shaft, Gagnon mine, Butte, resulted in death of four men and slight injuries to two.—Calumet & Hecla and its subsidiaries resumed work on full-time basis.—Germany put embargo on spelter.

Feb. 12—Calumet & Hecla announced resumption of dividends.

Feb. 18—First 1,500-ton unit of Alaska-Gastineau mill at Juneau started.

Feb. 23—Five miners arrested for high-grading in the Cripple Creek district, this being the beginning of a new crusade against this practice.

MARCH

Mar. 1—Increase of wages granted by the Quincy Mining Co.—Hoisting of ore resumed at Ashland mine, Gogebic Range.—Mountain Copper Co. resumed operation of its smeltery at Martinez.—Newport mine, Michigan, resumed full-time work.

Mar. 2—Explosion in the Layland mines (No. 3) of the New River & Pocahontas Consolidated Coal Co., near Quinnimont, W. Va., entombing about 160 miners; 47 men subsequently rescued.—Decision rendered in favor of Ontario Mining Co. in its suit against the Stewart Mining Co., of Idaho, for trespass.—Metal mining property of Golden Cycle Mining Co. sold to Vindicator Consolidated Gold Mining Co. for $1,500,000.

Mar. 3—Persons unknown dynamited and destroyed Green Copper shaft of Anaconda company at Butte.—President Wilson signed Foster bill providing for the establishment and maintenance of 10 mining-experiment stations and seven mine-safety stations in addition to those already established.—Sale of minority interest of Edgar Zinc Co.

Mar. 9—Judge Van Fleet in United States District Court rendered decision that the Mammoth Copper Co.'s plant at Kennett was doing no damage to the agricultural lands; company has resumed work.—New electric haulage system of Alaska Juneau mine started.

Mar. 13—Strike among the zinc smelters in Kansas and Oklahoma.

Mar. 15—St. Joseph Lead Co. increased production to 90% of normal.

Mar. 16—Mountain Copper Co.'s new concentrator at Keswick, Calif., started.—Cuyuna 1915 shipping season inaugurated.

Mar. 17—Twenty-stamp mill at Plumbago mine, Alleghany, Calif., destroyed by fire.—Compromise effected in strike of workers in Kansas and Oklahoma zinc smelteries.

Mar. 18—Crushing began at new mill of Rochester Mines Co., Nevada.—Mining and Metallurgical Society medal awarded to Prof. R. H. Richards.

Mar. 22—Snowslide at Howe Sound, B. C., swept away several bunkhouses at Britannia mine; 55 killed and many injured.

APRIL

Apr. 1—Spain placed embargo on iron, steel, tin, sulphur, aluminum, antimony, mineral oils and ammonia.

Apr. 7—Alaska Juneau Gold Mining Co. offered 400,000 shares capital stock at $10 per share.

Apr. 10—President Wilson announced the route of the Alaska Railway.

Apr. 12—Alaska Juneau stock offering oversubscribed four times and trading on Curb begun at $13 to $15 per share.

Apr. 15—Work resumed at East Butte mill.

Apr. 17—No. 1 dredge of Canadian-Klondyke began operations.

Apr. 19—New pumping machinery for draining downtown district of Leadville, Colo., started operation.

Apr. 22—Spelter at St. Louis passed 10c.

Apr. 29—Work begun at Ship Creek on construction of Government railroad in Alaska.

MAY

May 1—Crushing plant of Oliver Iron Mining Co., at Escanaba, Mich., started operations.—Lake Superior Hematite property of Oliver Iron Mining Co., Ishpeming, closed down and abandoned.—Calumet & Hecla company granted increase of 10% in wages of surface and underground men.—Decision by Judge Bourquin of the Federal Court in suit against the Anaconda company provides that the Alice mine property, sold some time ago to the defendant, shall again be offered for sale.

May 3—Stamp mill at White Pine mine, Ontonagon, Mich., started regular operation.—Alaska coal lands case nol-prossed at the request of the Attorney-General; said to be on account of lack of evidence.—Bullwhacker Copper Co., Butte, started operations after a long shutdown.

May 10—Decision rendered by United States Supreme Court in favor of the State of Georgia in its suit against the Ducktown Sulphur, Copper and Iron Co. for an injunction to prevent the company from allowing fumes to diffuse over the state border.—First cargo, 6,000 tons, of Broken Hill zinc ore delivered at Bartlesville, Okla.

May 17—New Washoe acid plant of Anaconda company put in commission.—No. 1 reverberatory at International smeltery, Miami, filled with calcines for first time.

May 18—Chile Exploration Co.'s plant at Chuquicamata started operations.—New record established at Duluth docks by loading 10 boats with 86,000 tons of ore in one 10-hr. shift.

May 19—Anaconda stockholders voted to change par value of stock from $25 to $50.

May 26—United Verde plant at Clarkdale started.

May 28—Utah, Nevada, Ray and Chino declared dividends; all raising rates except Ray, which was a return to the rate paid before passing its dividends.—Spelter at St. Louis passed 20c.

JUNE

June 1—Lower Lake freight rates on iron ores became effective.

June 2—J. P. Morgan & Co. announced purchase of $10,000,000 of 10-year 6% bonds of Kennecott Copper Corporation.—New iron and steel works of Broken Hill Proprietary Co., Ltd., at Newcastle, Australia, officially opened.

June 3—Decision adverse to the Government in its suit to dissolve United States Steel Corporation rendered by the Federal District Court at Trenton, N. J.

June 4—Prompt spelter at 27c., futures at 24@27c.; highest on record.

June 7—Amalgamated stockholders' meeting in Jersey City voted for dissolution of company.

June 9—Ohio Copper Co. leased mine and mill to General Exploration Co.—The Tonopah Merger and Tonopah Victor mines voted to merge with Tonopah Extension.—Electrolytic copper touched 20c., regular terms; Lake copper quoted at 23c.

June 10—Cave-in in Longacre Chapman mine, Joplin district, buried six men; four rescued after 120 hours' imprisonment.

June 12—Calumet & Hecla distributed bonus of over $500,000 among nearly 10,000 employees.—Lead touched 8c., but sales at that price were small and market immediately collapsed.

June 14—Stores in Butte forced to declare holiday on anniversary of big Butte labor riot in 1914 on account of action by clerks' union and defection in employers' association.

June 15—Last spike driven in Mascot & Western Ry., Arizona, connecting Mascot copper mines with Southern Pacific Co.—Attorney General of Missouri filed charge against zinc smelters.

June 16—Greene-Cananea resumed operations at mine and smeltery with two blast furnaces and one reverberatory.—Plant of La Harpe Spelter Co., Altoona, Kan., taken over by United States Smelting, Refining and Mining Co.

June 17—United States Steel Corporation announced its plan to build zinc works at Donora, Penn.

June 18—First section of Ohio copper mill started by lessee.—First copper produced at Cananea after long idleness.

June 20—Anglo-Colombian dredge No. 1 launched in Condoto River.

June 22—Disruption of the International Lead Convention owing to secession of the Australian producers.—Construction of Donora zinc plant started.

June 23—First copper made at Chuquicamata.

June 24—Success Mining Co., Idaho, changed hands by sale of 1,100,000 shares of stock for $1 a share.

June 28—Strike of zinc miners in Joplin district, Missouri.

June 29—Portland Gold Mining Co. given possession of Stratton's Independence.—First section of Inspiration mill put in operation.

June 30—Miami increased its dividend to 75c. quarterly.

JULY

July 1—New wage scale agreed on by miners and mine operators of Joplin.—New workmen's-compensation law of Montana went into effect.

July 7—New Jersey Zinc Co. increased its capital stock to $35,000,000.

July 12—Striking miners at Joplin, Mo., returned to work.—Dr. Joseph A. Holmes, Director of the United States Bureau of Mines, died.

July 15—Business section of Valdez, Alaska, destroyed by fire; loss, $500,000.—Coniagas Mine, Cobalt, Ont., celebrated the completion of a decade of mining.

July 17—Property of Iron Mountain Tunnel Co., Montana, purchased by Federal Mining and Smelting Co.

July 20—Ontario government appointed a commission to inquire into the feasibility of refining nickel ore entirely within the province.—Work commenced on a 1,300-ft. tunnel to carry water from Upper Annex Lake to provide extra power for the operation of the Alaska-Gastineau mill at Thane, Alaska.

July 21—New Jersey Zinc Co. paid stock dividend of 250% amounting to $25,000,000.

July 26—Beginning of suit of the North Star Mines Co. vs. Empire Mines and Investment Co.

July 30—Receivers appointed for Ohio Copper Co., following suit of Empire Trust Co. as trustee under the mortgage bond.

July 31—Books of the Amalgamated Copper Co. closed, thus terminating its official existence.—Strike at Aluminum Co. of America plant, Massena, N. Y.

AUGUST

Aug. 1—Workmen's-compensation law went into effect in Colorado.

Aug. 5—Dredge of the Empire Gold Dredging Co. in the Leadville district, Colorado, launched, this being the first dredge to operate in that district.

Aug. 13—Stocks of Belcher, Crown Point and Yellow Jacket dropped from the official list of the San Francisco Stock Exchange, these companies having been merged as the Jacket-Crown Point-Belcher Mines Co.

Aug. 15—Fire destroyed portion of the town of Upper Rochester, Nev.

Aug. 18—Spelter at 9½@10½c.

Aug. 21—E. W. King Dodds reported to have made first discovery in Kowkash district, Ontario.

Aug. 26—Zella mine, Jackson, Calif., sold to Kennedy Mining and Milling Co.—Hoisting plant of Victor Consolidated, near Mammoth, Utah, destroyed by fire.

Aug. 27—Vannoy H. Manning appointed Director of the United States Bureau of Mines.

Aug. 28—United Verde smeltery at Jerome, Ariz., closed.

Aug. 31—Explosion at Orenda mine of Merchants' Coal Co., at Boswell, Penn.; 19 killed.—Petition filed to dissolve Tintic Smelting Co.

SEPTEMBER

Sept. 1—Price of silver went to 46¼c., the lowest on record.—Sterling exchange went to 4.51c.

Sept. 2—Crushing started in Nevada-Douglas mill.

Sept. 10—Final decree of the Circuit Court filed at Trenton, N. J., dismissing suit against the United States Steel Corporation.

Sept. 11—Nechi dredge launched.

Sept. 12—Strike of miners at Clinton and Morenci, Ariz.

Sept. 14—Investigation of alleged zinc-smelting trust in Missouri started at Joplin.

Sept. 15—Holdings of Pittsburgh & Lake Angeline Co. sold to Cleveland-Cliffs Iron Co.

Sept. 16—Meeting of American Institute of Mining Engineers in San Francisco.

Sept. 20—Opening meetings of American Mining Congress and of International Engineering Congress, at San Francisco.

Sept. 21—Canadian-Klondyke dredge No. 2, which sank in 1914, righted and restarted.

Sept. 22—National Association of Mining and Stock Brokers organized at San Francisco.

Sept. 25—Old board of directors of Northport Smelting and Refining Co. resigned and new board elected.

Sept. 28—Unusually severe collapse of ground in Village Main Reef mine, Transvaal; 3 killed and 27 injured.

OCTOBER

Oct. 3—Arizona militia ordered to Clifton on account of strike disorders.—Crushing begun in mill of United States Gold Co., Boulder, Colo.

Oct. 9—Derry Ranch dredge, near Leadville, Colo., went into commission.

Oct. 11—Commencement of suit of Elm Orlu vs. Butte & Superior.

Oct. 13—Pilares mine of Moctezuma Copper Co. and the concentrator at Nacozari, Sonora, closed down.

Oct. 14—Production of electrolytic zinc begun at Anaconda, Mont.

Oct. 18—Stockholders of Tennessee Copper Co. approved the issue of $3,000,000 first-mortgage 10-year convertible 6% bonds.—Strike at Thetford mines, Quebec.

Oct. 19—Carranza government in Mexico recognized by the United States.—Explosion of dynamite at Granite Mountain mine, Butte, Mont., 16 men killed.

Oct. 20—First spelter made at Donora, Penn.

Oct. 22—Initial carload of potash shipped by Mineral Products Co., Marysvale, Utah.

Oct. 23—Stockholders of Southern Aluminium Co. voted to dissolve the corporation.

Oct. 25—Operations suspended at Cananea owing to cutting of railway by Yaquis.

Oct. 26—Beginning of strike at Silver King Coalition mine, Park City, Utah.

NOVEMBER

Nov. 1—Canadian Copper Co. adopted eight-hour day for all men at smeltery and shop and granted increase to men in mines working on an hourly rate.—Gaylord mill Cripple Creek, burned to the ground.—U. S. Supreme Court decided that Arizona anti-alien law was unconstitutional.

Nov. 2—Strike at Thetford mines, Quebec, settled.

Nov. 3—Utah Leasing Co.'s flotation plant started.

Nov. 5—Concentrator of Arizona Copper Co., Clifton, Ariz., partly destroyed by fire.

Nov. 6—Strike at Nichols copper refinery.—First manganese steel produced in Canada at Wabi Iron Works, Ontario.

Nov. 9—Strike at Silver King Coalition mine settled.

Nov. 10—Alice mine, Butte, reverted to Anaconda company, no offers having been made when offered at public sale.

Nov. 11—Mill of National Copper Co., Idaho, started operation.

Nov. 14—Law enacted in Peru levying export duty on gold, silver, copper and ores, with some exemptions, and on borax and petroleum.

Nov. 16—Strike at Nichols refinery settled.—Explosion in mine of Northwestern Improvement Co., at Ravensdale, Wash.; 34 men entombed, of whom three were rescued.

Nov. 17—Announcement of Kennecott-Braden consolidation.—New York & Honduras Rosario Mining Co. celebrated 35th anniversary of its operations.

Nov. 22—Federal investigation of Clifton strike begun.—Villa reported driven out of Cananea.

DECEMBER

Dec. 1—Nevada Packard mill, Rochester, Nev., started operation.

Dec. 8—Increase in dividends by Utah, Chino and Ray; Nevada Consolidated declared extra dividend of 12½c.—Midvale Steel and Ordnance Co. purchased Buena Vista Iron Co. property in Cuba.

Dec. 14—Announcement that Anaconda will build electrolytic zinc plant at Great Falls.

Dec. 17—Fire at works of Magnolia Metal Co., Matawan, N. J., which partially destroyed the plant.

Dec. 18—Villa announced his intention to leave Mexico.

Dec. 20—Special meeting of stockholders of Canadian Mining and Exploration Co. to authorize surrender of charter and dissolution of assets.

Dec. 22—British Government closed contract with Anaconda and A. S. & R. Co. for 60,000 long tons of copper, to be delivered during 1916, at about 20c. per lb.

Dec. 24—United States Court granted petition of Detroit Copper Mining Co. for order restraining strikers at Clifton from interfering with assessment work.

Dec. 27—Opening of second Pan-American Scientific Congress at Washington.

Dec. 28—Anaconda increased dividend.—U. S. Smelting, Refining and Mining Co. and Greene Consolidated resumed payment of dividends.

Dec. 29—Greene-Cananea resumed payment of dividends.

New Mining and Metallurgical Construction in 1915

Alaska Gold, Juneau, Alaska, completed installation of the first 6,000-ton unit of its mill.

William Martin, Knik, Alaska, completed 60-ton cyanide plant during summer; cost, $5,000.

Granite Gold, Hobo Bay, Port Wells, Alaska, constructed 65-ton mill, comprising 10 stamps and one 20-ton Lane mill, for crushing unit; total cost, $20,000.

Alaska Juneau, Juneau, Alaska, announced that George O. Bradley had been engaged to design and supervise construction of 8,000-ton mill, estimated to cost, together with hydro-electric power plant, etc., $4,000,000.

Miami Copper, Miami, Gila County, Ariz., remodeled concentrator, increasing capacity from 3,000 to 4,200 tons per day, at cost of $300,000.

Consolidated Arizona Smelting, Humboldt, Yavapai County, Ariz., installed oil-fired reverberatory furnace, 19 ft. by 100 ft., capacity 250 to 300 tons per day, at a cost of $50,000. Also started to erect new crushing and receiving plant to cost about $70,000.

Fortune Mining, Providence, Yavapai County, Ariz., working on 30-ton milling plant, to cost about $80,000.

New Cornelia Copper Co., Ajo, Pima County, Ariz., received authority from Arizona Corporation Commission to issue $675,000 of securities for construction Tucson, Cornelia & Gila Bend Ry., connecting mine at Ajo with main line of Southern Pacific at Gila Bend. Started construction of 4,000,-ton leaching plant. Estimated cost, $4,000,000.

Arizona Copper Co., Clifton, Greenlee County, Ariz., remodeled No. 4 mill at Clifton, to bring capacity up to 500 tons per day, also made some changes in No. 6 mill at Morenci, which increased capacity of that mill to 500 tons per day.

Bunker Hill, Tombstone, Cochise County, Ariz., remodeled old 40-stamp mill to 50-ton cyanide mill and 50-ton concentrate test-mill.

Primos Chemical Co., Primos, Penn., erected plant for treatment of tungsten ore at Russelville, Cochise County, Ariz.

International Smelting, Miami, Gila County, Ariz.; smeltery built primarily to smelt concentrates from Inspiration and Miami mines, put in operation. Estimated cost, $2,000,000.

Blickenstaff & Braun, Crown King, Yavapai County, Ariz., added Marathon mill and concentrating tables to stamp mill, increasing capacity to 150 tons per day; estimated cost of addition and improvements, $10,000.

Saratoga, Crown King, Yavapai County, Ariz., installed 150-ton plant to treat old dumps.

Leviathan Mines, Kingman, Mohave County, Ariz., drawing plans for mill for concentration of molybdenite ores.

De la Fontaine, Stockton Hill, Mohave County, Ariz., has enlarged mill to treat zinc ores from Shooting Star group.

American Molybdenum, Deluge Wash, Mohave County, Ariz., has erected small mill for treating molybdenum ores.

Superstition, Price, Pinal County, Ariz., has built small mill for treatment of gold ore.

Sunflower Cinnabar, Phœnix, Maricopa County, Ariz., investigating wet process in 50-ton plant; estimated cost, $25,000.

Duquesne Mining and Reduction, Duquesne, Santa Cruz County, Ariz., remodeled mill for installation of flotation equipment; capacity, 50 tons per day; estimated cost, $20,-000.

Union Basin, Golconda, Mohave County, Ariz., completed new regrinding and flotation plant, 200 tons' capacity.

Thorkildsen & Bierce, Patagonia, Santa Cruz County, Ariz., completed dry concentrator, 10-ton hourly capacity; cost, $20,-000.

Big Pine Consolidated, Prescott, Yavapai County, Ariz., started construction of cyanide plant, 80-ton capacity; cost, $50,000.

Gray Eagle Reduction, Mayer, Yavapai County, Ariz., completing 50-ton leaching and electrolytic-precipitation plant at cost of $60,000.

United Eastern, Oatman, Mohave County, Ariz.; at annual meeting voted to build 200-ton cyanide plant. Plans under way.

Copper Chief, Jerome, Yavapai County, Ariz.; Hayden Development Co. is erecting a 200-ton mill.

Calaveras Copper, Copperopolis, Calaveras County, added ball mill, Dorr classifier and thickener, Oliver filter and other mill equipment to bring capacity up to 200 tons per day; cost of improvement, $12,000.

American Trona, Trona, San Bernardino County, Calif. started work Aug. 16 on first unit of mill, capacity 100 tons potassium chloride and 40 tons of borax per 24 hr. at Trona; estimated cost, including the refinery at San Pedro, $400,000; at Searles Lake installed 750,000-gal. per day brine-pumping plant.

Stall Bros., Masonic, Mono County, Calif., installed 60-ton, 10-stamp mill with tube mill and cyanide equipment; estimated cost, $30,000.

Mammoth Copper, Kennett, Shasta County, Calif., built sorting and concentrating plant for zinc ore; capacity, 125 tons in 8 hr., at an estimated cost of $10,000.

Columbia Consolidated, Nevada City, Nevada County, Calif., built and put in operation 10-stamp mill; capacity, 50 tons per day; estimated cost, $20,000.

Melones Mining Co., Melones, Calaveras County, Calif., completed 450-ton cyanide plant for slime treatment of tailings.

Skidoo Mines, Skidoo, Inyo County, Calif., 10-stamp mill was enlarged by addition of five 1,250-lb. stamps, two Deister concentrators, and 40-hp. gas engine as auxiliary to present water power.

Merchants Finance Co., represented by M. Elsasser and Henry E. Simpson, New York City, constructed antimony-smelting plant at Harbor Industrial City, Calif. Capacity, 1,000 tons per month; cost, $75,000.

Phoenix, Randsburg, Kern County, Calif., added five stamps to five already in operation and increased size of cyanide plant by addition of 25-ton agitator.

St. Johns Mines, Vallejo, Solano County, Calif., completing 4 Scott tile-furnaces to handle coarse cinnabar ores.

Engels Copper, Keddie, Plumas County, Calif., addition to 250-ton concentration plant increasing capacity to 400 tons, includes flotation machinery, Minerals Separation, Ltd., process. Built 26-mi. electric power line from Butt dam of Great Western Power Co.

Shipsey Mining, Randsburg, Kern County, Calif., completed 5-stamp mill at King Solomon mine.

Union Copper, Milton, Calaveras County, Calif., 100-ton concentrating plant increased to 250-tons; includes flotation cells.

Natomas, Natoma, Sacramento County, Calif., completing reconstruction No. 4 dredge equipped with two tailing-stackers and double-deck tail sluices, for reclamation of ground coincident with dredging.

Red Mountain Magnesite, Livermore, Alameda County, Calif., completed three calcining kilns and constructed new road.

Dutch-App, Jamestown, Tuolumne County, Calif., completing improvements to stamp mill and installation of tube mill.

Trinity Asbestos, Castella, Trinity County, Calif., completed 12 mi. wagon road, 6% grade, cost about $45,000; saw-mill, capacity 25,000 ft. lumber in 24 hr., and 100-ton rock crusher.

Porterville Magnesite, Tulare County, Calif., completed milling equipment, 100-ton per day capacity.

Cerro Gordo Mines, Keeler, Inyo County, Calif., completed bucket tramway 29,000 ft. long, capacity 100 tons in 24 hr.; electric power line contracted for to replace steam.

Siskiyou Syndicate, Etna, Siskiyou County, Calif., completing 10-ton stamp mill; and ditch for carrying water.

Big Cliff, Etna, Siskiyou County, Calif., completed sawmill and cut lumber for tramway 7,700 ft. long, and surface buildings, mill, office and boarding house.

Alpine, Plymouth, Amador County, Calif., completing new steel headframe, carpenter and machine shops.

Mountain King Mining, Mountain King, Mariposa County, Calif., completed 30-stamp mill equipped with classification, concentration and regrinding machinery, and 400-hp. hydro-electric plant. Capacity of mill, 150 tons per day; cost, $50,000.

Ash Creek Mining, Hornbrook, Siskiyou County, Calif., completed 6-stamp mill; capacity, 18 tons; cost, $6,000.

Pittsburgh Liberty, Masonic, Mono County, Calif., mine and mill leased by Sarita Mining Co. and new machinery installed, including 10 stamps, tube mill and cyanide equipment, for capacity of 60 tons per day; cost, between $15,000 and $20,000.

Oro Water, Light and Power, Clements, San Joaquin County, Calif., constructed and started up 6-cu.ft. bucket dredge on Mokelumne River; capacity, 125,000 yd. per month; cost, $125,000.

Field's Process Smelter Fumes, Redding, Shasta County, Calif., expects to complete smelter fume-handling plant, 50-ton capacity, Jan. 1, 1916; estimated cost, $45,000.

Valley Pipe Line completed oil pipe line from Coalinga to Martinez, Calif., carrying capacity, 25,000 bbl. per day; cost, $4,500,000.

Laurence Gardella, Clear Creek, Shasta County, Calif., built dredge; capacity, 125,000 cu.yd. per month; cost, $100,000.

Walker Mining, Portola, Plumas County, Calif., completed half of first unit, 100 tons, flotation plant, at cost of $60,000.

Brunswick Consolidated Gold, Grass Valley, Nevada County, Calif., built 40-stamp mill; capacity, 120 tons per day; cost, $40,000.

Young America, Sierra City, Sierra County, Calif., reconstructed 160-ton cyanide plant at cost of $12,500.

Empire, Grass Valley, Nevada County, Calif., completed 60-stamp mill and 300-ton cyanide plant.

Delta Consolidated Gold, Bayles, Shasta County, Calif., completed 50-ton cyanide plant at a cost of $35,000.

Pacific Mineral Products, Los Angeles, Calif., completed 150-ton fine-grinding, lixiviating, pulverizing and air flotation plant; estimated cost, $150,000.

Harvard, Jamestown, Tuolumne County, Calif., built 150-ton cyanide plant.

Victor Power and Mining, Knob, Shasta County, Calif., added $60,000 equipment to present mining and milling plant; capacity, 250 tons per day.

Original Amador Consolidated, Amador City, Amador County, Calif., built new milling plant; twenty 1,000-lb. stamps; capacity, 300 tons per day.

United States Gold Corporation, Sugar Loafs, Boulder County, Colo., completed equipment of 150-ton cyanide and leaching plant—cost $150,000—by addition of 50- to 60-ton roasting plant at cost of $15,000.

Gold Hill Mining, Left-Hand Creek, Boulder County, Colo., completed 100-ton cyanide plant; cost, $62,000.

Colorado Utah Mines Operating completed 50-ton concentrating and flotation plant at Golden Fleece mine, Lake City, Hinsdale County, Colo., at cost of $25,000.

Ophir Range Gold, Ophir, San Miguel County, Colo., remodeled 100-ton plant at cost of $3,000.

American Mines, Goldhill, Boulder County, Colo., completed 25-ton unit of 50-ton amalgamation and concentration plant; estimated cost, $2,500.

Western Chemical Manufacturing, Denver, Colo., built new roaster plant at cost of $45,000.

Tomboy Gold, Telluride, San Miguel County, Colo., completed 400-ton tailing cyanide plant; estimated cost, $130,000.

Cripple Creek Cyanide Mining and Milling, Cripple Creek, Teller County, Colo., wet-crushing continuous-filter cyanide plant; 100 to 150 tons' capacity; estimated cost, $70,500.

Frank Caley, lessee on Jerry Johnson mine, Ironclad Hill, Cripple Creek, Colo., constructed 100-ton cyanide plant.

Dumont Custom Mill, Dumont, Clear Creek County, Colo., installed 25-ton amalgamation and concentration plant at cost of $5,000.

Boulder Tungsten Production, Nederland, Boulder County, Colo., installed 30-ton concentration plant at cost of $20,000.

Down Town Mine, Leadville, Lake County, Colo., erected and equipped 500-ton plant at cost of $55,000.

American Ore Flotation, Silverton, San Juan County, Colo., made improvements at Animas mill of Garfield Smelting Co. and repairs to power plant. Estimated cost, $30,000.

Iowa, Silverton, San Juan County, Colo., installed flotation unit at cost of $3,000.

Gold King, Gladstone, San Juan County, Colo., installed additional flotation units at cost of $10,000.

Sunnyside, Eureka, San Juan County, Colo., made improvement to stamp mill, increased capacity of electrostatic plant and added flotation unit. Estimated cost of improvements, $30,000.

Hamlet Mining and Milling, Howardsville, San Juan County, Colo., added conical mill and flotation unit at cost of $8,000.

Mears-Wilfley, Silverton, San Juan County, Colo., added flotation unit and lined flume with vitrified tile.

Silver Ledge, Chattanooga, San Juan County, Colo., remodeled mill at cost of $15,000.

Boise-Rochester Mining, Atlanta, Elmore County, Idaho, built 100-ton stamp, concentrating and cyanide plant.

Highland Surprise Con., Kellogg, Shoshone County, Idaho, added $2,000 flotation unit to treat slimes from 100-ton mill.

Reindeer Queen, Mullan, Shoshone County, Idaho, preparing to install flotation plant.

Federal Mining and Smelting, Gem, Shoshone County, Idaho, completed 400-ton concentration mill.

Bunker Hill & Sullivan Mining and Concentrating Co., Wallace, Shoshone County, Idaho, announced plans for building $1,000,000 lead-smelting plant, either in Cœur d'Alenes or on Pacific Coast.

Overlook, Atlanta, Elmore County, Idaho, installed 10-stamp mill and Bleichert tramway.

H. E. & M., Wallace, Shoshone County, Idaho, completed 100-ton concentration mill including flotation machinery.

Idaho-Continental, Porthill, Bonner County, Idaho, started construction of lead-concentrating mill, mining plant and tramway; mill capacity, 250 tons; estimated cost, $55,000. To be completed Mar. 1, 1916.

Caldwell Chemical, Evansville, Ind., began work on 100-ton-per-month picric-acid plant at Spottsville, Ky.

Penn Iron, Vulcan, Mich., erected two crushing plants, one at Curry and one at Brier Hill shaft; total cost, $22,000.

Isle Royale, Houghton, Mich., started rebuilding its $150,000 mill destroyed by fire, Dec. 24, 1914. Capacity, 2,000 tons per day.

Minnesota Steel Co., Duluth, Minn., resumed construction on and completed part of plant on which work was stopped last year after nearly $10,000,000 had been spent. Total cost when completed, $25,000,000.

Inland Steel Co., Brainerd, Minn., built small concentrator at Thompson mine near Crosby. Contracted for 70-hp. electric current from local power company.

Pittsburgh Steel Ore, Riverton (Cuyuna Range), Minn., built concentrating mill for iron ore; capacity 3,000 tons for single shift; estimated cost, $300,000.

Cleveland Cliffs Iron, Nashwauk, Minn., at Crosby mine, built iron-ore washing plant with capacity of 50,000 tons crude ore, 30,000 tons concentrates, per month, at estimated cost of $100,000.

Universal Portland Cement, New Duluth, Minn., completed cement plant begun in 1913; capacity, 1,400,000 bbl. of cement per year; estimated cost, $1,800,000.

Duluth & Iron Range R.R., Two Harbors, Minn., started work on installation of $1,500,000 concrete-steel ore dock, to replace old No. 2 wooden dock being dismantled.

Mattes Bros., Galena, Kan., built new concentrating plant, capacity 500 tons in 12 hr.; motive power, natural gas, 150-hp. gas engine; cost, $30,000.

Empire Mining, Galena, Kan., bought and remodeled old Tiwah mill, bringing capacity to 200 tons in 10 hr.; added 150-hp. gas engine.

W. H. Wahling, Galena, Kan., built new concentrator, capacity 250 tons in 10 hr., and installed 150-hp. gas engine; cost, $22,000.

George Monlux, Galena, Kan., built new concentrator, capacity 150 tons in 10 hr.; installed 100-hp. gas engine; cost, $15,000.

Sparkler, Galena, Kan., built new lead and zinc concentrator, 4 mi. northwest of Galena, capacity 300 tons per 10 hr.; cost $30,000.

D. A. Mansur, Joplin, Mo., bought Yellow Jacket mill and moved same to Duenweg, Mo., remodeled and enlarged to 300 tons in 10 hr.

Lucky George, Joplin, Mo., built new concentrator at Belle Center, 3 mi. northwest of Joplin, capacity 150 tons in 10 hr.; cost, $17,500.

George Kruester and Associates, Webb City, Mo., completed new lead and zinc concentrator, 300 tons' capacity in 10 hr.; cost, $25,000.

New England Mining, Joplin, Mo., built lead-zinc concentrating plant at Klondyke, 4 mi. northwest of Joplin, capacity 250 tons in 10 hr.; installed 150-hp. gas engine, estimated cost, $25,000.

Picher Lead, Galena, Kan., built two lead-zinc concentrating plants at Picher, Okla., capacity 300 tons each in 10 hr.; installed gas engine and compressors at both plants;

estimated cost, $30,000. Is now building third plant at same place.

Athletic Mining, Duenweg, Mo., enlarged mill to 1,000 tons' capacity per 24 hours. Installed compressor and 300-hp. boiler.

Wayland, Galena, Kan., erecting 500-ton concentrating plant; estimated cost, $25,000.

Stott Mining, Duenweg, Jasper County, Mo., built zinc- and lead-ore concentrating plant; capacity, 500 tons per 10 hr.; cost, $40,000.

La Harpe Spelter, Kusa, Okla., has under construction 10 furnaces—400 retorts each.

Oklahoma Spelter, Kusa, Okla., has 4 furnaces—400 retorts each—under construction.

Inter-Mountain Copper, Iron Mountain, Missoula County, Mont., built 100-ton copper concentrator at cost of $60,000.

St. Paul Mont. Mining, Maiden, Fergus County, Mont., completed a 50-ton cyanide plant; cost, $45,000.

Anaconda Copper, Great Falls, Cascade County, Mont., completed 2,000-ton copper plant—leaching and flotation—for treatment of 15,000,000 tons of accumulated tailings; and 100-ton sulphuric-acid plant. Estimated cost of improvements, $6,000,000. Also completed copper refinery, capacity 15,000,000 lb. copper per month, at cost of $1,350,000. In December broke ground for construction of zinc plant to cost $2,000,000 and have capacity of 70,000,000 lb. zinc per annum.

Natural Products Refining, Jersey City, N. J., manufacturer of bichromate of potash and bichromate of soda, is building extension to plant at estimated cost of $50,000.

Cossak Mining, Bland, Sandoval County, N. M., completed 100-ton cyanide plant at cost of $100,000.

Pinos Altos M. & M., Pinos Altos, Grant County, N. M., installed 50-ton concentrator at cost of $25,000.

Empire Zinc, Pinos Altos, Grant County, N. M., installed 150-ton electro-magnetic zinc plant.

Empire Zinc, Silver City, Grant County, N. M., has completed 150-ton concentrator, 9 mi. north of Silver City.

Chino Copper, Hurley, Grant County, New Mexico, reports no new construction during 1915.

Northern Ore, Edwards, St. Lawrence County, N. Y., completed 100-ton mill for concentrating zinc ore to replace mill burned in 1914.

Rochester Mines Co., Rochester, Humboldt County, Nev., completed and put in operation 100-ton fine-grinding and cyanide mill. Book cost, $87,000.

Nevada Packard Mines Co., Rochester, Humboldt County, Nev., completed 100-ton cyanide plant, equipped with crusher, rolls, tube mill and zinc-dust precipitation. Cost, $70,000.

Nevada-Douglas, Ludwig, Lyon County, Nev., constructed 250-ton leaching plant.

Pittsburgh-Dolores, Rockland, Lyon County, Nev., completed 80-ton cyanide mill. Estimated cost, $40,000.

George Wingfield, Reno, Washoe County, Nev., has taken option on Boundary Red Mountain Gold Mining Co. in Mt. Baker district, Washington, one mile from British Columbia boundary and 90 mi. east of Vancouver, and is installing ten 1,000-lb. stamps and small tube mill for regrinding, equipped for amalgamation only.

Consolidated Nevada-Utah, Pioche, Lincoln County, Nev., broke ground Dec. 15, 1915, for erection of 50-ton concentrating mill, to cost $35,000 to $40,000. Completion expected Mar. 15, 1916.

Goldfield Great Bend, Re-Inc., Goldfield, Esmeralda County, Nev., installed hoist, compressor and mining machinery, at cost of $10,000.

Mason Valley, Mason, Lyon County, Nev., reports no new construction.

Colorado-Nevada M. & M., Nelson, Clark County, Nev., erected and put in operation a 75-ton Dorr counter-current cyanide plant.

Techatticup Syndicate, Nelson, Clark County, Nev., installed 40-ton Dorr counter-current cyanide plant.

Amalgamated-Pioche, Pioche, Lincoln County, Nev., commenced work on 75-ton crushing and 50-ton milling plant with oil flotation; estimated cost, $35,000.

Sunset M. and D., Rhyolite, Nye County, Nev., additional equipment consisting of ball mills, classifiers, etc., to increase capacity from 50 to 100 tons per day, at cost of $6,000.

Sultan, Good Springs, Clark County, Nev., installed dry-concentration mill; capacity, 25 tons per 8-hr shift; total cost, $8,000.

New Hope, Eagleville, Churchill County, Nev., started construction of 150-ton cyanide plant; estimated cost, $50,000.

Goodsprings Anchor, Jean, Clark County, Nev., installed dry-concentration plant; capacity, 50 tons per 24 hr.; cost, $8,000.

Yuba Leasing and Develop., Pioche, Lincoln County, Nev., installed 50-ton concentration and cyanide plant; cost, $30,000.

Belleville Tailings Association, Belleville, Esmeralda County, Nev., completed 130-ton cyaniding plant for treating old tailings, at cost of $30,000. Construction started May, 1914.

Elko Prince, Midas, Elko County, Nev., built all-slime cyanide plant; capacity 50 tons; estimated cost. $75,000.

Monitor-Belmont, Belmont, Nye County, Nev., completed 150-ton stamp mill equipped with ten 1,650-lb. stamps, tube mills, and oil flotation; capacity, 150 tons per day, cost, $70,000.

Aurora Consolidated, Aurora, Mineral County, Nev., installed new apparatus in 500-ton all-slime cyanide plant; cost, $45,000.

United States Steel Corporation started construction and finished one unit of zinc-smelting plant for the production of zinc and byproducts, including sulphuric acid, at Donora near Pittsburgh, Penn. Estimated cost, $2,500,000 to $3,000,000.

Good Hope Mining Co., Keystone, S. D., completed 10-stamp mill; capacity 40 tons. Cost, $10,000.

Homestake Mining, Lead, S. D., practically completed installation of central boiler plant, containing 3,600-hp. boilers; electric generating station—steam-driven units—4,000-kv.-a. capacity; compound condensing steam hoists for handling two 6-ton skips from depth of 4,000 ft.; estimated cost, $500,000.

Rattlesnake Jack, Galena, S. D., equipped with 10-stamp mill, Wilfley tables, conical mill and cyanide machinery; capacity, 75 tons per day.

Mogul, Terry, S. D., installed a second 100-hp. De La Vergne oil engine, for purpose of increasing mill capacity to 150 tons daily.

Wasp No. 2, Deadwood, S. D., installed in mill at Flatiron, Wilfley concentrator, jig, ball mill, rolls and full equipment for handling 25 tons daily of low-grade wolframite ore; cost, $5,000.

Echo Gold, Maitland, S. D., installed prospecting equipment, including air compressor, hoist, sinking pump, etc., at a cost of $6,000.

Golden Gate Mining Co., Greenhorn, Baker County, Ore., completed 35-ton amalgamation plant. Cost, $45,000.

Imperial, Cable Cove, Baker County, Ore., increased 60-ton amalgamation and concentration plant to 100-ton; cost of increased capacity, $15,000.

American Zinc, Mascot, Tenn., erected 700-ton zinc-concentrating mill; estimated cost, $100,000.

Clinchfield Products Association, 100 William St., New York City, started construction of $500,000 plant at Johnson City, Tenn., for manufacture of lithophone and kindred products.

Utah Copper, Bingham, Salt Lake County, Utah, reports no new construction during 1915.

Silver King Conlition, Park City, Summit County, Utah, erected a 400-ton flotation plant; estimated cost, $75,000.

Utah Leasing, Newhouse, Beaver County, Utah, installed 500-ton plant for flotation of concentrates; estimated cost, $50,000.

United States Smelting, Midvale, Salt Lake County, Utah, made 100-ton addition to lead and zinc concentrator and 40-ton addition to zinc mill. Also built new custom lead and zinc concentrator with capacity of 150 tons.

Daly Judge, Park City, Summit County, Utah, installed 150-ton per day Callow flotation equipment.

Tintic Milling, Silver City, Juab County, Utah, building chloridizing and leaching plant; capacity, 300 tons; estimated cost, $200,000; to treat local custom ores.

Utah-Apex, Bingham, Salt Lake County, Utah, installed 250-ton flotation equipment at cost of $22,000.

Broadwater Mill, Park City, Summit County, Utah, installed 500-ton water concentration plant for treating old tailing dumps.

Big Four Exploration, Park City, Summit County, Utah, built 250-ton concentration plant at Atkinson, below Park City to treat tailings.

Caldo, Frisco, Beaver County, Utah, built 200-ton flotation mill—Callow process—to treat tailings from the Horn-Silver mill.

United Copper Co., Chewelah, Stevens County, Wash.; 50 stamps added, making 74 now in operation. Mill also includes oil-flotation process. Total capacity, 235 tons per day.

Hammond Mining Co., Glacier, Whatcom County, Wash., reconstructed old milling plant and added modern cyanide equipment.

Lucky Six Mining, Livingston, Wis., installed 100-ton zinc concentrator at cost of $8,250, at Dodger mine, near Mifflin.

Field Mining and Milling Co., New Diggings, Wis., completed 450-ton zinc-concentrating mill. Cost, $30,000.

Oliver Iron, Shullsburg, Lafayette County, Wis., built 400-ton mill at zinc mine; estimated cost, $80,000.

Vinegar Hill Zinc constructed three plants, each with a capacity of 150 tons per 10 hr., cost $15,000 each, at Kittoe and Graham mines at Benton and at Blackstone mine at New Diggings, Wis.

B. M. B., Mifflin, Wis., built zinc mill at Biddick mine, capacity 100 tons per 10 hr.; estimated cost, $8,000.

Treganza, Benton, Wis., built zinc mill, capacity 100 tons in 10 hr.; estimated cost, $8,000.

McMillan, Hazel Green, Wis., built 100-ton mill at McMillan mine; estimated cost, $8,000.

Saxe-Pollard, Linden, Wis., built 100-ton plant at Gilman mine, cost $8,000.

Longhenry Bros., Benton, Wis., at Longhenry mine, built 100-ton zinc mill; estimated cost, $8,000.

Blockhouse, Platteville, Wis.; at Cruson mine building 150-ton plant; estimated cost, $15,000.

M. & H., Platteville, Wis.; at Loomis mine built 50-ton mill; cost, $4,000.

Optimo, Linden, Wis.; at Optimo No. 3 built 100-ton zinc mill at estimated cost of $8,000.

Stoner Bros., Linden, Wis., built 50-ton zinc plant; estimated cost, $4,000.

K. C. & M., Benton, Wis.; at Wilkinson mine built 75-ton plant; estimated cost, $4,000.

Wisconsin Zinc, New Diggings, Wis., built Skinner roaster, capacity 800 tons of green ore per week; estimated cost, $75,000.

Mineral Point Zinc, Mineral Point, Wis., built new acid plant at Mineral Point and is now building Skinner roaster.

Great Western, Galena, Ill., moved and reassembled Brown-Croft roaster—Mathey type.

Galena Refining, Galena, Ill.—an affiliation of the Field Mining and Milling Co.—is reassembling the Mills roaster (Mathey type), at Galena.

McIntyre-Porcupine, Schumacher, Ont., Canada, added new 150-ton unit to cyanide plant at cost of $55,000.

Tough-Oakes, Kirkland Lake, Ont., Canada, completed 120-ton mill and cyanide plant; estimated cost, $127,000.

Miracle, Porcupine, Ont., Canada, completed mill and cyanide plant, 50 tons' capacity.

Weedon, Welland, Ont., Canada, installed additional concentrating machinery and 50-ton flotation plant at lead-zinc mine near Notre Dame des Anges, Quebec; concentrates to be shipped to company's zinc works at Welland.

Algoma Steel Corporation, Ltd., Ontario, Canada, extensive improvements made on roasting plant at Magpie mine. Capacity of drying plant at powdered-coal mill was doubled.

Schumacher Gold Mines, Ltd., Schumacher, Ontario, Canada, completed 150-ton cyanide plant. Cost, $75,000.

Cobalt Reduction, Cobalt, Ont., Canada, completed 300-ton concentrator and 175-ton cyanide plant; estimated cost, $83,000.

Dome Mines, Ltd., South Porcupine, Ont., Canada, started work on addition to present mill, which has capacity of 28,000 tons per month; ultimate total capacity 45,000 tons per month. Installed underground crusher station and power haulage, 120 tons' capacity per hr., at cost of $30,000.

Weedon Zinc, Ltd., Welland, Ont., Canada, completed first unit of electrolytic zinc refinery; capacity, 5 tons of spelter per day.

Coniagas Mines, Ltd., Cobalt, Ont., Canada, completed canvas plant of 80 to 90 tons' capacity at cost of $3,000 and cyanide plant of 6 to 8 tons' capacity at cost of $8,000.

Hollinger Gold, Timmins, Ont., Canada, added 40 stamps and new tube mill to previous equipment of 60 stamps.

Teck Hughes, Kirkland Lake, Ont., Canada, started work on construction of 100-ton mill and power plant.

Canadian Copper, Sudbury, Ont., Canada, has new shaft-house, warehouse, machine and carpenter shops at Creighton mine completed, and new rockhouse in course of construction.

Canadian Mining and Finance, Ltd., Timmins, Ont., Canada, has completed construction of central power plant at Gillies Lake, with four air compressors, each with a capacity of 4,500 cu.ft.

BENZOL PLANTS

United States Steel Corporation built three benzol plants —one at Farrell, Penn., one at Gary, Ind., and one at Birmingham, Ala. These plants have a combined capacity of approximately 26,000 gal. of crude benzol per day.

Otto Coking, New York City, contracted to build benzol plant in connection with the byproduct coke ovens of the Citizens Gas Co., of Indianapolis.

Lehigh Coke, South Bethlehem, Penn., built plant with capacity to take care of gas from 3,000 tons of coal per day, fuel consumed in two batteries of 212 byproduct coke ovens of the Koppers type.

Benzol Products, Marcus Hook, Penn., plant for the production of benzol built jointly for General Chemical Co., American Coal Products Co. and Semet-Solvey Co.

Republic Iron and Steel, Youngstown, Ohio, built and put in operation at its byproduct works at Youngstown, plant for manufacture of benzol and its homologues, with a capacity of 5,500 gal. of chemically pure products per day.

Dominion Steel Corp., Sydney, N. S., Canada, completed and put in operation benzol plant for manufacture of benzol and toluol, which are also produced at byproduct coke plant at Sault Ste. Marie.

Crows Nest Pass Coal, Fernie, B. C., started construction of plant for manufacture of benzol and toluol for the British army.

Tennessee Coal, Iron and Railroad, Birmingham, Ala., constructed benzol plant at Fairfield with capacity to recover from byproduct gases 15,000 gal. of benzol every 24 hr.

Woodward Iron, Woodward, Ala., plant erected by Edison Laboratories Co., of Orange, N. J., to utilize gas from by-product plant at Woodward. Capacity 2,000 gal. of benzol per day.

Lackawanna Iron and Steel, Buffalo, N. Y., built and started operation of benzol plant at its Lebanon works; capacity 1,600 gal. per day.

Zenith Furnace, Duluth, Minn., built and started operating benzol plant, with capacity of 600 gal. per day.

Illinois Steel, Gary, Ind., reported started construction of benzol laboratory at Joliet, Ill., to cost $800,000 and to be ready by Feb. 1.

Newport Hydro Carbon, Carrollville, Wis., is erecting plant to manufacture coal-tar products; estimated cost, $100,000. The Newport Mining Co., Ironwood and Bessemer, Mich., is interested in this project.

Important Books of 1915

Among the more important books on mining and metallurgy published during 1915 were the following:

Bauer, O., and Deiss, E. "The Sampling and Chemical Analysis of Iron and Steel." Translated from the German by William T. Hall and Robert S. Williams. (373 pp., $3.)

Clennell, J. E. "The Cyanide Handbook." Second edition. (601 pp., $5.)

Ingalls, W. R., Douglas, James, Finlay, J. R., Channing, J. Parke, and Hammond, John Hays. "Rules and Regulations for Metal Mines." Bull 75, United States Bureau of Mines. (296 pp.)

Johnstone, Sydney J. "The Rare Earth Industry." (136 pp.)

Lewis, J. Volney. "Determinative Mineralogy." Second edition. (155 pp., $1.50.)

Lunge, George (Editor). "Technical Methods of Chemical Analysis." Vol. III. (1,125 pp., $18.)

MacFarren, H. W. "Practical Stamp Milling and Amalgamation." Third edition. (231 pp., $2.)

Park, James. "A Text Book of Practical Assaying." (342 pp.)

Pirsson, Louis V., and Schuchert, Charles. "A Test Book of Geology." (1,051 pp.)

Ries, Heinrich, and Watson, Thomas L. "Engineering Geology." (772 pp., $4.)

Rosenhain, Walter. "An Introduction to the Study of Physical Metallurgy." (368 pp., $3.50.)

Skinner, Edmond Norton, and Plate, H. Robinson. "Mining Costs of the World." (406 pp., $5.)

Thomson, Francis Andrew. "Stamp Milling and Cyaniding." (285 pp., $3.)

White, Charles H. "Methods of Metallurgical Analysis." (356 pp., $2.50.)

Wiard, Edward S. "The Theory and Practice of Ore Dressing." (426 pp., $4.)

Antimony

For many years American consumers have been in the habit of buying Cookson's and Hallett's antimony to the exclusion of practically all other brands, though naturally other brands found their way to this market from time to time. With the outbreak of the war, Great Britain required all the antimony its smelters could make, and though shipments are still reaching this country from England, they are made under special permit, difficult to obtain.

The Chinese, who are undoubtedly the largest producers of antimony in the world, saw their opportunity, opened an office in New York and started a vigorous campaign to make their product known. They have been exceedingly successful. Their metal is of a very good quality, and every month has seen it arriving in New York in large quantities. This antimony is introduced here by the Wah Chang Mining and Smelting Co., which has at Changsha a very modern and efficient plant.

Prices fluctuated considerably, and until the last stoppage of the Panama Canal the market had gradually dropped to about 25@26 per lb. for antimony in bond.

AVERAGE PRICES OF ANTIMONY

(In Cents per Pound)

	1913			1914			1915	
	Cookson's	U. S.	Ordinaries	Cookson's	U. S.	Ordinaries	Cooksons'	Ordinaries
January	9.94	9.53	8.97	7.388	7.110	6.125	17.90	15.85
February	9.47	9.09	8.25	7.250	7.057	6.100	21.25	18.21
March	9.28	8.85	8.18	7.315	7.073	6.053	28.75	22.13
April	9.13	8.50	7.98	7.363	7.048	6.006	31.88	24.88
May	8.88	8.37	7.79	7.365	7.020	5.845	42.70	35.30
June	8.79	8.27	7.64	7.250	7.000	5.825	47.50	37.69
July	8.54	8.08	7.55	7.210	6.940	5.638	50.44	38.13
August	8.38	7.91	7.39	17.250	15.800	13.800	48.00	33.00
September	8.37	7.93	7.37	11.830	.....	9.940	44.56	28.63
October	7.60	7.27	6.49	14.680	.....	12.060	45.50	31.45
November	7.62	7.30	6.45	17.750	.....	14.450	47.25	38.88
December	7.50	7.25	6.13	16.130	.....	13.310	55.00	39.25
Year	8.73	8.22	7.52	10.732	.....	8.763	40.06	30.28

Note—Hallett's was not quoted in 1915, for lack of sales.

By the land-slide large quantities were held up, the spot position became acute, and our market advanced by leaps and bounds to 40c. for spot. Part of the metal that was held up was unloaded at San Francisco and sent overland to this port. Other shipments went around Cape Horn.

After the war between Russia and Japan, antimony prices reached their highest point about eight months after the conclusion of hostilities, as the warring nations and those who had supplied the belligerents were replenishing their stocks. Some think that at the conclusion of this war we shall not see a similar advance. It is true that Germany, Austria and their allies have had no opportunity of importing antimony, but it is known that not only these countries, but also neutral countries that were prevented from getting antimony by the strict contraband laws, have changed their method of cartridge-making entirely. In former years the steel or cupro-nickel bullets were filled with antimonial lead; now new installations have been made to produce a steel mantle of greater thickness in which pure lead is placed.

Next to China, Japan sends the largest quantities of antimony to this market. The high prices for the metal induced several concerns in this country to start antimony smelting. Most important of these seems to be the Western Metals Co., of Los Angeles, which is managed by persons who were previously connected with Cookson & Co., Newcastle-on-Tyne. Antimony smelting has been started on the Atlantic Coast, though not to any extent as yet. The difficulty has been the getting of suitable ores. As China no longer ships antimony ore and Australia has put an embargo upon the shipments, the ores found in this country, in Alaska and South America had to fill the bill. Transport difficulties in Alaska are the main obstacles to getting the supplies from there, though the ore is of an exceedingly good quality. Several thousand tons are said to have reached this country during the open season.

In South America competition for the ore has been exceedingly acute. English and French refiners, and even Japanese refiners, competed with the American buyers, and the prices paid for South American ore are far in excess of that paid for the Alaskan or for the domestic ore. Whereas the bulk of the Alaskan ore was sold at a price of about $1.40@1.50 per unit, the South American ore has not failed to realize $1.85 per unit; but at that figure little business was done, and most contracts were closed over $2 per unit. In December business for fair-sized quantities was concluded at $2.55 per unit c.i.f. New York. The domestic product has the advantage, of course, of not having to pay the duty of 10%, and if the ore supply can be maintained, domestic antimony should be a permanent feature of the antimony business in the future.

The antimony smeltery at Chelsea, Staten Island, was idle, but the Magnolia Metal Co. inaugurated antimony smelting in Brooklyn. Antimony mines in all parts of the United States were rejuvenated, and several little furnaces were built. Stibnite deposits are being worked 10 mi. north of Neuralia, Kern Co., Calif., and also at Wild Rose Spring, at the foot of Telescope Peak in the Panamint Range, 25 or 30 mi. northeast of Trona. One of these companies has a smeltery at Industrial Harbor, a part of San Pedro. It is said that the Cottrell process is being used to save the fumes.

Several smelteries were reported in operation in Mexico in spite of the disturbances in that country. However, no attempt was made to exploit the great deposit of jamesonite that is known to exist.

Production of Petroleum

Estimates of the petroleum production in the United States in 1915 indicate a slight increase over the record-breaking year of 1914. According to the figures of John D. Northrop, of the United States Geological Survey, the "marketed production" of petroleum in 1915 was 267,400,000 bbl., and the total yield about 291,400,000; approximately 24,000,000 bbl. of oil brought to the surface during the year was placed in field storage. The stocks of crude petroleum held by pipe-line companies at the end of 1915 approximated 195,000,000 bbl.; this reserve was about 50,000,000 bbl. greater than at the end of 1914. Mr. Northrop's estimate of the "marketed production" by states is given in a table on page 80.

Production in the Appalachian region was for the most part of routine character. Tennessee returned to the ranks of oil-producing states with a 50-bbl. well at Oneida, in Scott County, near the Kentucky boundary; at the end of the year 6 active wells were reported in the Oneida field. The Lima field recorded its usual decline despite some new wells in Seneca County, Ohio. Illinois' output also declined, reducing its rank to fourth place as an oil-producing state.

In the Mid-Continent field, the Cushing pool held the center of interest during the first part of the year, but

experienced a rapid decline. Attention was then centered on the Healdton pool in Carter County, Oklahoma, where the daily outpt increased from 25,000 bbl. to 75,000 bbl.

Northern Louisiana made a considerable increase by reason of the oil and gas wells brought in near Crichton, east of the Red River. In the Panhandle region of northern Texas oil and gas were discovered near Strawn. A small oil field of unique geological conditions was found near Thrall, in Williamson County, in the south-central part of the state. Late in the year oil was found near San Antonio, in Bexar County, and near Brenham, in Washington County. In the Gulf Coast field Humble retained first rank, increasing its daily output from 35,000 to 75,000 bbl. The deep test well at Spindletop drilled by the Gulf Production Co. was finished to a depth of 4,720 ft. without discovery of oil or gas in paying quantity. Louisiana pools in the Gulf field were featureless except for slightly increased activity in the Edgerly pool.

"MARKETED PRODUCTION" OF PETROLEUM IN 1914 AND 1915

State	1914	1915
California	99,775,327	89,000,000
Oklahoma	73,631,724	80,000,000
Texas	20,068,184	26,000,000
Illinois	21,919,749	18,500,000
Louisiana	14,309,435	18,500,000
West Virginia	9,680,033	9,000,000
Pennsylvania	8,170,335	8,700,000
Ohio	8,536,352	7,900,000
Wyoming	3,560,375	4,200,000
Kansas	3,103,585	3,000,000
Indiana	1,335,456	1,000,000
New York	938,974	900,000
Kentucky	502,441	450,000
Colorado	222,773	200,000
Other states	7,792	50,000
Total	265,762,535	267,400,000

The output of Wyoming increased materially, the Grass Creek and Greybull pools being chiefly responsible. Fremont County added some new wells, but the most important development was on the Silvertip anticline in Park County, along the Montana boundary; this field was extended across the line into Carbon County, Montana. Important gas wells were encountered in Bighorn County, Wyoming, and at Havre, Mont. No oil was reported from Utah, and Colorado's production was from the declining Florence, Boulder and Rangely fields. Test wells in Washington, Oregon, Arizona and Maryland resulted in commercial failures.

California production declined in 1915, largely because of overproduction of previous years and consequent discouragement of prospecting. The fields south of the Tehachipi range exhibited more activity than the San Joaquin Valley fields. In the Midway-Sunset field, the last of the big gushers—Miocene No. 2—ceased flowing in March, and no wells of corresponding size were completed. A new field was opened north of McKittrick by the Belridge Oil Co.'s No. 4 well at a depth of 4,000 ft. Near Oil City the deepening of an old well in the white-oil district resulted favorably, and a revival of activity is expected in this section.

Mining Stocks in 1915 on the New York Exchanges

The accompanying tables show the 1915 quotations on mining stocks in the New York Stock Exchange and the New York Curb. The year saw a most remarkable rise from the low figures of January, which were maintained by fixed "minimum prices" in some cases, and was marked on the big board by a decided increase in the number of mining listings. For Curb prices and stocks on the New York Stock Exchange, in 1914, refer to the *Journal* of Jan. 9, 1915, page 88, and for bond prices on the New York Stock Exchange see the *Journal* of Jan. 16, 1915, page 157.

STOCKS ON THE NEW YORK STOCK EXCHANGE

Company	First	High	Date	Low	Date	Last	Total Sales
Alaska Gold Mines‡‡	26⅛	40½	Apr. 22	21⅛	Dec. 9	25	1,543,120
Alaska Juneau Gold Mining‡‡	13	13½	Nov. 4	9⅜	Dec. 9	10	387,950
Allis-Chalmers Mfg	8	49⅛	Oct. 4	7⅜	Jan. 12	31⅛	2,634,426
Allis-Chalmers Mfg. pf.	35	85⅞	Dec. 30	33	Feb. 10	82	566,844
Amalgamated Copper	51⅜	79½	Apr. 24	50⅝	Feb. 24	72	3,033,746
Amer. Smelt. and Ref. Co	56	108⅞	Dec. 31	56	Jan. 2	108½	2,512,805
Amer. Smelt. and Ref. Co. pf	100	113	Nov. 18	100	Jan. 4	112½	45,655
American Smelters pf. A	86	92	Dec. 31	86	Sept. 30	91⅛	23,121
American Smelters pf. B	78	85⅛	Dec. 6	78	Jan. 19	85⅛	14,169
Amer. Zinc, Lead and Smelt.‡	69½	71½	Dec. 24	67⅛	Dec. 29	69	25,850
Anaconda Copper Mining Co.†	50⅛	91⅜	Nov. 17	49½	Feb. 24	91⅜	3,747,121
Butte & Superior‡‡	68½	79¼	June 4	53	May 10	72⅛	544,134
Batopilas Mining††	⅛	4½	Dec. 9	⅛	Feb. 5	3⅜	243,457
Bethlehem Steel Co.	46½	600	Oct. 22	46¼	Jan. 2	459½	1,522,382
Bethlehem Steel Co. pf.	91	184	Oct. 22	91	Jan. 2	145	94,028
Chile Copper‡	26	26⅜	Nov. 24	23⅜	Dec. 13	24⅜	90,352
Chino Copper†††	33½	57⅜	Nov. 17	32⅜	Jan. 6	55½	1,372,153
Colorado Fuel and Iron	22	66½	Sept. 29	21⅛	Jan. 5	52½	2,148,480
Comstock Tunnel	9c.	21c.	June 3	7c.	May 29	11c.	356,850
Crucible Steel Co.	21⅜	109⅞	Sept. 29	18½	May 10	73	4,622,045
Crucible Steel Co. pf.	86	112½	Sept. 29	84	May 10	111	114,284
Dome Mines	17½	30½	Dec. 6	16	June 25	28⅞	377,584
Federal Min. and Smelt.	10	60	June 12	8	Mar. 24	32½	45,046
Federal Min. and Smelt. pf.	29⅞	65	June 12	20	Mar. 13	53⅛	186,815
General Chemical Co.	165½	360	Oct. 8	165	Jan. 26	328½	15,708
General Chemical Co. pf.	108½	116	Dec. 10	106	Mar. 1	116	7,172
Granby Consol.	79½	91	June 14	79½	Apr. 19	80	1,170
Great Northern pf.	112⅜	128⅜	Nov. 5	112⅜	Jan. 2	127⅛	570,095
Great North. ctfs. for ore prop.	25½	54	Oct. 22	25¼	Jan. 2	51⅜	2,666,165
Greene Cananea‡‡	42½	52⅞	Dec. 27	37	Oct. 22	50½	69,700
Guggenheim Exploration‡	45½	83½	Dec. 31	45¼	Jan. 7	83½	1,159,845
Guggenheim Ex. ex. div.	23½	23½	Dec. 31	22	Dec. 31	23	13,800
Homestake Mining	116	124	Dec. 9	116	Feb. 24	124	5,718
International Nickel v. tr. cfs	215	223½	Oct. 5	179¾	Dec. 3	198	91,661
Internat. Nickel pf., v. tr. cfs	107	110	Oct. 5	105½	Oct. 19	108	1,025
Lackawanna Steel Co.	28	94½	Sept. 29	28	Jan. 7	81	934,182
Miami Copper†††	17⅜	36½	Dec. 31	17¼	Jan. 6	36	1,036,347
National Lead Co.	44	70⅜	May 1	44	Jan. 4	66½	573,618
National Lead Co. pf.	104½	115	Nov. 15	104½	Jan. 4	110	13,621
Nevada Con. Copper Co.†††	11⅞	17	Nov. 17	11⅜	Feb. 24	16½	391,395
Ontario Silver Min.	2	12⅜	Dec. 9	2	Feb. 23	9⅞	262,932
Pittsburgh Steel pf.	74	102½	Dec. 1	74	May 12	102½	8,590
Quicksilver	1⅜	5⅛	Nov. 1	¼	Mar. 15	4½	96,820
Quicksilver pf.	1⅜	6¼	Nov. 1	¼	Mar. 29	4½	45,705
Ray Consolidated Copper‡‡	15½	27⅛	Nov. 17	15¼	Jan. 2	25⅞	1,541,206
Republic Iron and Steel Co.	19⅜	57⅛	Dec. 9	19	Feb. 1	55½	1,802,265
Republic Iron and Steel Co. pf.	75	112⅜	Dec. 14	72	Jan. 30	110	117,194
Sloss-Sheffield Steel and Iron	24	66⅞	Dec. 7	24	Jan. 6	63½	288,974
Sloss-Sheffield Steel and I. pf.	85	102	Dec. 30	85	May 6	102	6,930
Tennessee Copper‡	32½	70	Sept. 30	25½	Feb. 24	63¼	1,378,229
U. S. Reduction and Ref.	1⅜	10⅜	June 14	1⅛	Apr. 26	3⅜	51,845
U. S. Reduction and Ref. pf.	1	10½	June 14	1	Apr. 9	4	30,385
U. S. Steel Corporation.	49	89½	Dec. 27	38	Feb. 1	88⅛	23,222,017
U. S. Steel Corporation pf.	105	117	Oct. 30	102	Feb. 1	117	344,324
Utah Copper‡‡	49½	81½	Dec. 28	48½	Jan. 5	81½	2,762,984
Vulcan Detinning	5	19	Oct. 22	5	Jan. 21	12	13,590
Vulcan Detinning pf.	21	43	Oct. 29	21	Jan. 22	43	1,185

Highest and lowest prices of the year are based usually on sales of 100 shares. Where prices are used for less than that amount they are marked with an asterisk (*). † Par $50. ‡ Par $25. †† Par $20. ‡‡ Par $10. ††† Par. $5.

BONDS ON THE NEW YORK STOCK EXCHANGE

Bond	High	Low	Last	Total Sales
Alaska Gold M. 10-yr. conv. deb.' 25	150	112½	117	868,000
Am. Smelt. Sec. 15-yr. s. f. 6s, 1926	115½	103⅜	114½	3,877,000
Beth. Steel 1st ext. gtd. s. f. 5s, 1926	103	98½	102½	2,040,000
Beth. Steel 30-y. 1st and r. m. gtd. 5s, '42	102½	85½	101⅞	12,194,500
Chile Copper conv. 7s, 1923	141	111	135	2,928,000
Col. Fuel and Iron gen. s. f. g. 5s, 1948	95	87	94	82,000
Granby Consol. conv. 6s, Series A	111	98	104	1,172,000
Granby stamped	105	102½	104	295,000
Illinois Steel deb. 4½s, 1940	92½	82⅞	91	2,163,000
Indiana Steel 1st mtge. 5s, 1952	102½	99	101⅜	1,835,000
Inspiration Cons. Cop. conv. 6s, 1922	190	97	185	15,768,500
Lacka. Steel 1st cv. g. 5s, 1923	98½	89	98½	1,795,000
Lacka. 1st con. mtg. 5s, Ser. A, 1950	97	65	92½	15,346,500
Ray Con. Cop. 1st mtg. cv. 6s, 1921	140	103	129	2,866,500
R. I. & S. 10-30-yr. s. f. mtg. 5s, '40	97½	90½	97	2,295,000
Tenn. Cop. sub. rects. for 1st 10-yr. cv. 6s, f.p.	136	117	124½	276,000
U. S. Red. & Ref. 1st sk. fd. 6s, 1931	30½	20	23	115,000
U. S. Steel Corp. 10-60 yr. g. s. f. 5s, '63	105	99⅞	104½	19,370,000
U. S. Steel Corp registered	105	99¾	104¼	297,000
Va. Iron, Coal & C. 1st g. 5s, 1949	90½	82	89	226,000

MINING STOCKS ON THE NEW YORK CURB—1915

Company	Open	High	Low	Last	Total Sales
Atlanta	*44	50	15	22	2,787,160
Alta Con Min	*22	23	8	15	751,100
Alaska Juneau	14	16⅛	17	12⅞	343,675
Albion Mining	*47	48	41	41	31,500
Am. Commander	*9	17	7	8	917,575
Ariz. Cons.	6¼	6¼	6¼	6¼	100
Ariz. Duquesne	*25	40	25	37	345,750
Beaver Consolidated	*39	39	39	39	200
Blue Bell	*6	6¼	3	6	88,900
Blue Bull	*11	11	4½	6	196,800
Big Cottonwood	*12	13	3	5	424,600
Big Ledge Dev. Co	1⅛	4¼	1⅛	1⅛	140,922
Braden Copper	6⅜	18	6¼	17⅛	1,052,127
Bingham Mining	8½	8¾	8½	8¾	200
Booth	*41	58	34	39	461,300
Butte Cop. and Zinc	2⅛	10¼	2⅛	6⅞	168,800
Buffalo Mines	⅛	1⅛	1/16	1⅛	11,400
Butte-New York	⅛	4	⅛	3½	159,935
Butte & Superior	40	69	40	64	5,510
Cactus Mining	*42	45	42	45	300
Calaveras Cop	2⅛	4½	2¼	4⅛	9,350
Caledonia Copper	*74	1⅛	*74	87	312,645
Can. Copper	1⅛	2⅛	⅛	2⅛	373,700
Caribou Cobalt	*63	63	30	35	42,955
Cashboy	*7	10	3	5⅛	739,100
Chile Copper, w. i.	22½	26¾	17⅛	25⅛	403,985
Cerro de Pasco Cop	55	55	35½	39	68,445
C. O. D	*7	9	4	4½	174,200
Combination Fraction	*10	11	6	8	37,500
Comstock Tunnel	*13	17	8	10	99,200
Cons. Ariz. Smelt	⅜	1⅛	¼	1⅛	1,161,690
Cons. Copper Mines	2⅛	2⅛	1⅛	2	18,775
Consolidated Nev.-Utah	¼	¼	*17	1/16	399,550
Crown Reserve	⅜	1⅛	⅜	¼	14,616
Daly-West	3⅛	3⅛	3⅛	3⅛	1,000
Davis-Daly Copper	1	2⅛	1	2⅛	2,800
Dia. Black Butte	*6½	9	2	4	242,780
Dome Ex	7	36	7	26	190,035
Dome Lake	23½	24	23½	24	2,000
East Caledonia	*24	24	24	24	1,000
Ely Con	*7	12	7	9½	149,400
El Paso Con	1⅛	1⅛	1	1	100
Emma Copper	*34	92	16	21	1,092,900
Federal Reserve Min	18	20	16	17	130,600
First Nat'l Copper	1⅛	10	1⅛	8⅞	2,834,810
Florence	*58	83	35	47	150,959
Foley O'Brien	*25	37	25	28	2,700
Genesee	*33	44	33	33	64,520
Gold Hill	¼	⅜	¼	⅜	30,100
Goldfield Cons	1⅛	1⅛	1⅛	1⅛	273,466
Goldfield Merger	*34	43	14⅛	18	1,501,700
Greene-Can., new	24	44⅛	23⅛	42	62,057
Greenw. Cop. M. & S	*4⅛	4⅛	4⅛	4⅛	200
Guanajuato Con	⅜	⅜	⅜	⅜	400
Halifax Tonopah	*30	42	25	30	7,750
Hecla Mining	3⅛	4	2⅛	3⅛	29,310
Howe Sound, w. i.	2⅛	7⅛	2⅛	7⅛	185,940
Inter. Mines Dev. Co	*30	30	15	23	1,563,000
Iron Blossom	*70	1⅛	*61	1⅛	107,820
Jim Butler	*96	1⅛	*96	1⅛	56,950
Jumbo Extension	2⅛	2⅛	*50	1⅛	2,608,201
Kerr Lake	4⅛	5⅛	3	5	67,070
Kewanas	*29	47	9½	20	1,416,730
Kennecott Copper	25	59⅛	25	56⅛	2,132,000
Keystone Mining	3⅛	3⅛	3⅛	3⅛	200
Lake Superior	10	13⅛	10	12	3,920
La Rose Consol	⅜	1	⅜	⅜	93,115
Lone Star	*12	13	3⅛	4	210,205
Magma Copper	12⅛	16⅞	12⅛	15⅜	150,960
Majestic Mines	*60	2	*40	1⅛	296,968
Marsh Mining	*38	38	29	33	73,555
Mason Valley	1⅛	4⅛	1⅛	4⅛	6,250
McIntyre	*43	1.10	39	93	164,900
McKinley-Darragh	*58	73	19	43	511,773
Mines Co. of Am	2⅛	4⅛	2	3⅛	46,410
Montana Con	1⅛	1⅛	⅛	¼	38,500
Mother Lode	*17⅛	52	17⅛	26	3,771,550
Nat. Zinc and Lead	*35	3⅛	*33	2⅛	133,470
Nevada Hills	32	37	16	20	60,390
New Utah Bingham	*58	5⅛	*58	4⅛	159,193
Nipissing Mines	5⅛	8⅛	5⅛	8⅛	298,430
No. Butte Develop	⅛	⅛	⅛	⅛	66,600
Ohio Copper	⅛	⅛	⅛	⅛	2000
Oro	*12⅛	16	5	6	204,900
Pacific Smelters	⅛	¼	1/16	⅛	7,500
Peterson Lake	38	40	32	38	221,500
Ray Hercules	7	7	3⅛	3⅛	516,400
Rex Con. Min	*37	57	23	30	987,185
Rochester Mines	*67	1 1/16	*54	54	164,900
Sandstorm Kendall	*7	14	4	8⅛	316,750
San Toy	18⅛	27	15	25	179,060
Santa Fe	5⅛	5⅛	3	3⅛	76,825
Sells	*36	38	20	32	122,250
Seven Troughs Coalition	45	48	44	44	37,700
Silver Pick	*6	12⅛	6	7	204,010
South Utah Mines	1/16	1/16	*10	⅛	13,720
Stand. Silver-Lead	1⅛	2⅛	1⅛	1 1/16	375,995
Stewart	1⅛	2⅛	1/16	⅛	871,165
Success Mining	*64	1⅛	*56	65	2,113,265
Superstition M. C	*18	36	18	32	1,068,905
Temiskaming	*48	75	48	65	62,400
Tonopah Belmont	4 1/16	5⅛	4⅛	4⅛	21,570
Tintic Mining	⅛	1⅛	⅛	1⅛	4,500
Tonopah Merger	*35	63	30	55	454,065
Tonopah Extension	2 1/16	4⅛	2⅛	4 1/16	330,032
Tonopah of Nev	7⅛	7⅛	5	6⅛	56,559
Tularosa	⅛	⅛	⅛	⅛	109,200
Tuolumne	*25	1⅛	*23	⅛	251,970
Trinity Copper	13	13	12½	12	550
Tri-Bullion	⅛	⅛	⅛	1⅛	361,619
United Copper	¼	¼	⅛	¼	200
U. S. Continental Min	17	17	13	14	26,600
United Verde Ex	6⅛	6⅛	6⅛	6⅛	300
Utah Con	14⅛	14⅛	14⅛	14⅛	175
Wasatch	1⅛	1⅛	⅛	⅛	135,611
West End Cons	*58	*100	50	80	460,625
West End Ex	*3	8	2	3	619,780

MINING STOCKS ON THE NEW YORK CURB—(Continued)

Company	Open	High	Low	Last	Total Sales
Wettlaufer Silv. Mines	*3	12	3	10	41,200
Wh. Knob. Cop. pfd	1⅛	3⅛	1	2	49,350
Yukon Gold Mine	2⅛	3⅛	2⅛	2⅛	49,295

Total Sales

1915	41,158,026	1914	11,004,172	1913	10,576,792
1912	12,689,773	1911	11,772,314	1910	34,172,548

Bonds

Company	Open	High	Low	Last	Sales
Alaska G. M. 6s w. i.	112⅛	120	112⅛	118⅛	32,200
Braden Copper 6s	137⅛	340	137⅛	335	1,808,000
Braden Copper 7s	138	340	138	322⅛	203,000
Cerro de Pas. Cop. 6s	118	122	117	121	1,574,000
Cons. Ariz. 5s	15	34	15	33	202,950
Chile Copper 7s	106	120⅛	105	116⅞	1,337,000
Ely Cent. 6s	⅛	⅛	1/16	⅛	27,900
Kennecott Cop. 6s	112	228	108	226	6,791,000
United Lead deb. 5s	71	74	71	74	5,000

*Cents per share.

Aluminum

The price for aluminum was steady at about 19c. per lb. up to the middle of May. An improvement in the demand then manifested itself, and it swelled until aluminum became a very scarce article, the price rising to 60c. per lb. in the latter part of 1915. At the high prices it became profitable for electric companies that had installed aluminum transmission wires to take them down, sell the aluminum and replace it with copper. This was done to a considerable extent. Although the quotations for aluminum rose as high as 60c. per pound in the last quarter of 1915, the bulk of the production went into consumption at very much lower figures, the contract prices of the principal producers having ranged from 20c. to 31c. per lb.

In a recent speech at Detroit, A. V. Davis, president of the Aluminum Co. of America, stated that his company was then producing 18 lb. of aluminum where 10 lb. was made in 1914. This would indicate an American production of about 80,000,000 lb. in 1915. The British commandeered the production of the company's plant situated in Canada, wherefore that supply—8,000 to 10,000 tons per annum—is going to England instead of coming to the United States, as heretofore.

AVERAGE MONTHLY PRICE OF INGOT ALUMINUM

(At New York, in Cents per Pound).

Year	1912	1913	1914	1915	Year	1912	1913	1914	1915
Jan	19.13	26.31	18.81	19.08	July	23.50	23.38	17.66	32.38
Feb	19.44	26.04	18.81	19.22	Aug	24.38	22.70	19.88	34.50
Mar	19.58	27.05	18.50	19.00	Sept	25.13	21.69	19.94	47.75
April	20.38	27.03	18.16	18.88	Oct	26.25	20 13	18.50	50.00
May	21.69	26.44	17.95	22.03	Nov	26.56	19.35	18.00	57.75
June	22.83	24.68	17.75	30.00	Dec	25.75	18.88	18.96	57.13
					Year	22.01	23.64	18.63	33.98

The Aluminum Co. of America is planning greatly to increase its capacity. A big water power, estimated at 800,000 hp., is being developed on the St. Lawrence River. During 1915 the Aluminum Co. of America bought out the Southern Aluminium Co., which became involved in financial difficulties in 1914, and immediately took steps to complete the plant at Whitney, N. C., whereof construction had been interrupted. The following summary of the aluminum industry in 1915 is based on authoritative information:

The aluminum market in 1915 followed closely the market for other metals. During the first quarter of the year the supply of aluminum was ample and the price remained about 20c. per lb. During the succeeding quarter the surplus began gradually to diminish, and for the last six months of the year the demand was in excess of the supply. This situation was brought about in part by the gradual reviving of business in this country and the consequent increase in consumption of aluminum,

partly by the gradual cessation of importations and partly by the increasing urgency and demand in Europe for aluminum for war-munition purposes. The price gradually rose from 20c. to 31c., although during the last quarter resales have been made at prices substantially in excess of those asked by the domestic manufacturers.

The domestic manufacturers adopted the policy of conserving the entire United States production for United States consumers. The result has been that while there was considerable pressure to get aluminum, nevertheless the domestic consumer was taken care of. While some took advantage of the urgency of the foreign market and resold their aluminum at high profits, this was not a general practice, and in consequence the domestic consumer obtained and used all that he required. The president of the Aluminum Co. of America stated in Detroit a few weeks ago, at an address given before the Society of Automobile Engineers of America, that his company had not sold any aluminum for munitions or for war purposes, but that nevertheless, considerable resold alumimum had gone out of the country for this purpose derived from aluminum transmission wires that had been replaced by copper.

In the same address he stated that the company was bending every energy to increase its output and that as soon as its new works are finished, on which it is now working and which it expects to complete in 1916, whatever pressure now exists for an additional supply of aluminum would be relieved, and furthermore, that his company was proceeding on other substantial enlargements for 1917 and following years, and that, so far as he could see, after the present pressure is relieved the market would be settled and normal for years to come.

It will be of interest to note that the extreme demand from Europe arose largely from the increase in the use of ammonal, an explosive which has been known for a great many years but which was not until the last few months used in large quantities by the European belligerents. Ammonal is a mixture of nitrate of ammonia and powdered aluminum. The aluminum burns at the time of the explosion and, by imparting a high heat to the explosive gases, causes them to expand to a volume considerably greater than they otherwise would. Ammonal has heretofore been considered unreliable on account of its tendency to absorb moisture, but either because the belligerents found some way to overcome this or because the ammonal is used so soon after its manufacture, this objection seems no longer to hold, and aluminum was in great demand in Europe for this purpose.

Bismuth

The world's supply of bismuth is derived chiefly from Bolivia, where the mines of Aramayo, Francke & Co. at Chorolque and Tasna, the product of which is smelted at Quechisla and Buen Retiro, are the principal producers. This company in 1914 produced 437 tons of impure bars and 112 tons of ore. The company recently reported that in its fiscal year ended May 31, 1915, it produced 73¾ tons more of crude bismuth than in 1913-14. However, the sales were 64 tons less, owing to the lock-up of stocks in Germany, while new refining works were being established in England. On the other hand, the average price realized was 22c. per lb. better than in the previous year.

In the United States bismuth is produced as a byproduct by the principal silver-lead smelting and refining companies. The price for bismuth in the United States at the beginning of 1915 was $2.75 per lb. In the latter part of the year it rose to $4 per pound.

No new producers of bismuth in the United States have offered metal to the trade. Importations from abroad have been cut off, and with the demand steady, the accumulations of other years has been used and there is little spot metal available at the end of 1915.

Potash Production Begun in United States

Steps were finally taken in 1915 to produce potash salts on a commercial scale in the United States. While Searles Lake will undoubtedly be the most important source of potash for some years to come, the war conditions permitted other sources to be developed. The alunite deposits near Marysvale, Utah, thus became the first important producers of potash in the United States.

The plant of the Mineral Products Corporation, organized by Howard F. Chappell, began the production of potash on a commercial basis at Marysvale in October, 1915. This plant, in which the Armour Fertilizer Works and the U. S. Smelting, Refining and Mining Co. are interested, produces both potassium sulphate and alumina in high-grade form. The potash shipments have averaged about 95% K_2SO_4, and the rated capacity of the works is from 25 to 30 tons per day; the grade of the product and the capacity of the plant are largely dependent on manipulative skill and are gradually being brought up to rated efficiency as the operators are becoming more experienced. Shipments of alumina have also been made; various uses are being developed for this product, a large market as a refractory being expected. The present plant handles about 150 tons of alunite daily and plans are being made to double its capacity.

At Searles Lake, California, the American Trona Corporation proceeded with the construction of its works to treat the potassium-bearing brine of that desert basin by the Grimwood process. For reasons of economy of operation and better shipping facilities, it was decided to produce at Trona (Searles Lake) only mixed salts from the first part of the process and to refine these mixed salts at the port of San Pedro, Calif. The initial plants are expected to produce 100 tons of potash and 30 tons of borax daily. The crude-salt plant at Trona is to be ready in March, 1916, and the refinery at San Pedro a few weeks later.

The alunite deposit of the Florence Mining and Milling Co., in the Marysvale district of Utah, is to be exploited by a newly formed corporation, the Utah Potash Co. Investigations were also made of the possibilities of utilizing the tailings of certain mines, leucite, green-sand marl, mica, feldspar and kelp. Some plants were erected to utilize the potash of the feldspars, but did not get into operation on a commercial scale. Work was begun in 1915 on a plant at Great Salt Lake to extract potash from the brines of the evaporating ponds of the Inland Crysal Salt Co. In their present development practically all of these are war-time processes that could not compete with the German producers on a pre-war basis. However, potash will probably never be so cheap as it was before the war. It is one of those commodities on which it will be most easy for Germany to levy and collect taxes in the future.

Mining Dividends in 1915

The tables which follow show the dividends paid in 1914, 1915 and to date by the principal mining, metallurgical and holding companies of America. The list includes practically all United States mining companies that have paid dividends since 1906, except a few that have ceased to have a separate corporate existence.

The total of $75,383,387 disbursed by 109 companies in mining dividends sets a new record for the United States. While it is a remarkable showing as compared with the $60,323,529 paid last year by 90 companies, it is not a great increase over 1913, when 110 companies paid $73,440,701. The most significant fact is that in December of 1915 the dividends were greater than those of December, 1913, and December, 1914, combined and amount to more than 25% of this year's total.

As we have always pointed out, however, these dividends do not mean the receipt by the public of these amounts. For instance, a large share of Nevada Con.'s payments go to Utah Copper, while Champion's are split equally between St. Mary's Mineral Land and Copper Range. On the other hand, there are large producers which do not make their dividend public, although this policy is becoming less common.

With the metallurgical and holding companies, the 1915 payments are $82,592,194, while in 1914 they were $90,434,677 and in 1913, $99,740,693. However, in 1914 the Steel Corporation common paid $21,602,856 and in 1913 $24,415,125, against nothing in 1915.

As most mines are commercial producers of two or more metals, no attempt is made to classify them as copper producers, lead producers, etc.

Canadian and Mexican mines paid $10,686,384, against $15,231,122. The silver mines of Canada suffered severely through the low price of that metal while Mexico was under the blight of revolution and rebellion, although recovery began late in the year.

DIVIDENDS OF MINING COMPANIES IN THE UNITED STATES

		SHARES		DIVIDENDS PAID						
				1914		1915		To Date	Latest	
COMPANY NAME	SITUATION	Issued	Par Value	Per Share	Total	Per Share	Total	Total	Date	Amount
Acacia, g	Colo.	$1,438,989	$1	.....	.....	.....	.....	$122,004	Jan. '11	$0.00½
Adams, s.l.c	Colo.	80,000	10	.....	.....	.....	.....	778,000	Dec. '09	.04
Ahmeek, c	Mich.	50,000	25	6.00	$300,000	$15.50	$775,000	3,175,000	Nov. '15	2.50
Alaska Goldfields	Alas.	250,000	5	.12	30,375	.12	30,375	403,250	Jan. '15	.12
Alaska Mexican, g	Alas.	180,000	5	.80	144,000	.50	90,000	3,507,381	Nov. '15	.10
Alaska Treadwell, g	Alas.	200,000	25	5.50	1,100,000	3.25	650,000	15,535,000	Nov. '15	.50
Alaska United, g	Alas.	180,200	5	.90	162,180	1.40	252,280	1,991,210	Nov. '15	.30
Allouez, c	Mich.	100,000	25	.....	.....	1.00	100,000	100,000	July '15	1.00
Am. Zinc, Lead & Sm	Kan.	171,200	25	.50	85,600	.....	.....	1,108,820	Jan. '14	.50
Anaconda, c	Mont.	2,331,250	25	2.50	11,171,250	.....	6,993,750	99,573,125	Nov. '15	1.00
Anchor, s	Nev.	500,000	1	.....	.....	.06	30,000	30,000	July '15	.03
Argonaut, g	Calif.	200,000	5	1.80	360,000	.60	120,000	1,700,000	Dec. '15	.10
Arizona Copper, pf	Ariz.	1,426,120	1.20	a	119,221	a	119,221	2,129,062	Nov. '15	.....
Arizona Copper, com	Ariz.	1,519,896	1.20	.54	821,003	.42	646,336	18,461,338	July '15	.24
Bagdad-Chase, g., pf	Calif.	184,819	5	.....	.....	.....	.....	202,394	Jan. '09	.10
Bald Butte, g.s	Mont.	250,000	1	.....	.....	.....	.....	1,344,648	Oct. '07	.04
Baltic, c	Mich.	100,000	25	.....	.....	.....	.....	7,950,000	Dec. '13	2.00
Beck Tunnel, g.s.l	Utah	1,000,000	.10	.....	.....	.....	.....	940,000	Oct. '09	.02
Benton, z.l	Wis.	196,607	1	.....	.....	.....	.....	10,949	Oct. '08	.01½
Bingham-New Haven, c	Utah	228,690	5	.20	45,738	1.00	228,690	614,485	Dec. '15	.20
Board of Trade, z	Wis.	120,000	1	.....	.....	.....	.....	78,000	Jan. '11	.05
Bonanza Dev., g	Colo.	300,000	1	.....	.....	.....	.....	1,425,000	Oct. '11	.20
Boss, g	Nev.	408,500	1	.10	40,850	.....	.....	40,850	Dec. '14	.10
Boston-Sunshine, g	Utah	150,200	1	.....	.....	.....	.....	27,261	Nov. '11	.03½
Brunswick, g	Calif.	395,284	1	.18	71,152	.18	71,152	179,598	Sept. '15	.06
Bull, Beck & Champ., g	Utah	100,000	10	.....	.....	.....	.....	2,728,400	July '08	.10
Butte-Alex. Scott, c	Mont.	79,311	10	.....	.....	.15	23,793	209,457	Oct. '15	.15
Bunker Hill Con., g	Calif.	200,000	1	.30	60,000	.30	60,000	870,000	Dec. '15	.02½
Bunker Hill & Sull., l.s	Ida.	327,000	10	3.00	981,000	3.25	1,062,750	16,773,000	Dec. '15	.50
Butte & Ballaklava, c	Mont.	250,000	10	.....	.....	.....	.....	125,000	Aug. '10	.50
Butte & Superior, z	Mont.	271,136	5	2.25	610,054	18.00	3,898,001	4,509,909	Dec. '15	8.25
Caledonia, l.s	Ida.	2,605,000	1	.05	130,250	.20	421,000	703,300	Dec. '15	.02
Calumet & Arizona, c	Ariz.	617,412	10	3.00	1,851,008	3.25	2,006,557	23,148,224	Dec. '15	1.25
Calumet & Hecla, c	Mich.	100,000	25	10.00	1,000,000	50.00	5,000,000	129,250,000	Dec. '15	15.00
Camp Bird, g.s	Colo.	1,100,051	4.86	.....	.....	.24	267,312	9,750,836	Nov. '15	.24
Camp Bird, pfd., g	Colo.	650,000	4.86	.34	221,130	.34	221,130	945,150	July '15	.17
Cardiff, l.s	Utah	500,000	1	.....	.....	.25	125,000	125,000	Oct. '15	.25
Centennial-Eur., l.s.g.c	Utah	100,000	5	1.50	150,000	.....	.....	4,050,000	Apr. '14	1.50
Center Creek, l.z	Mo.	100,000	10	.20	20,000	.35	35,000	550,000	Oct. '15	.15
Champion, c	Mich.	100,000	25	.....	.....	31.00	3,100,000	11,500,000	Dec. '15	2.00
Chief Con., s.g.l	Utah	880,545	1	.10	87,676	.10	88,053	351,037	Nov. '15	.05
Chino, c	Ariz.	869,980	5	2.50	2,169,065	3.00	2,609,860	6,697,995	Dec. '15	1.00
Cliff, g	Alas.	100,000	1	.....	.....	.....	.....	210,000	Dec. '13	.05
Cliff, s.l	Utah	300,000	1	.....	.....	.....	.....	90,000	Jan. '13	.10
Colo. Gold Dredging	Colo.	100,000	10	3.50	350,000	.....	.....	675,000	Sept. '14	1.00
Colorado, l.s.g	Utah	1,000,000	.....	.....	.....	.....	.....	2,570,000	Dec. '12	.03
Columbus Con., l.g.s	Utah	285,540	5	.....	.....	.....	.....	226,832	Oct. '07	.20
Commercial Gold	Ore.	1,750,000	1	.....	.....	.....	.....	43,750	Dec. '09	.00¼
Comstock Phoenix, s	Nev.	800,000	1	.....	.....	.....	.....	40,000	Nov. '11	.05¼
Con. Interstate-Callahan, z.	Ida.	460,000	1	.....	.....	5.50	2,530,000	2,530,000	Dec. '14	1.50
Con. Mercur, g	Utah	1,000,000	1	.....	.....	.....	.....	3,445,313	July '13	.03
Continental, z.l	Mo.	22,000	25	1.00	22,000	11.00	242,000	551,000	Dec. '15	10.00
Copper Range Con., c	Mich.	393,714	100	.....	.....	.....	.....	13,986,746	Oct. '13	.50
Daly-Judge, s.l	Utah	300,000	1	.60	180,000	1.00	300,000	1,155,000	Dec. '15	.35
Daly West, s.l	Utah	180,000	20	.....	.....	.....	.....	6,606,000	Jan. '13	.15
De Lamar, g.s	Ida.	80,000	5	.....	.....	.....	.....	875,000	Aug. '11	.25
Dr. Jack Pot Com., g	Colo.	3,000,000	.10	.....	.....	.....	.....	45,000	Mar. '11	.00½
Doe Run, l	Mo.	65,782	100	.....	.....	.....	.....	3,550,969	Dec. '13	.76
Ducktown, c	Tenn.	199,800	4.86	.39	.....	.24	48,600	.....	.....	.....
Dunkin, g	Colo.	200,000	1	.....	.....	.....	.....	10,000	Oct. '13	.05
Duluth & Utah Dev., l.s	Utah	50,000	.20	.12	6,000	.08	4,000	10,000	Mar. '15	.04
Eagle & Blue Bell, g.s.l	Utah	893,146	1	.15	133,972	.15	133,972	446,573	Dec. '15	.05
Elkton Con., g	Colo.	2,500,000	1	.08	200,000	.04	100,000	3,579,460	May '15	.02
El Paso, g	Colo.	490,000	5	.10	49,000	.....	.....	1,707,545	Feb. '14	.10
Ernestine, g.s	N. M.	300,000	5	.....	.....	.10	30,000	150,000	July '15	.10
Federal M. & Sm., com	Ida.	60,000	100	.....	.....	.....	.....	2,708,750	Jan. '09	1.50
Federal M. & Sm., pf	Ida.	120,000	100	5.00	599,305	4.00	479,444	9,466,392	Dec. '15	1.00
Florence, g	Nev.	1,050,000	1	.....	.....	.....	.....	840,000	Apr. '11	.10
Frances Mohawk, g	Nev.	912,000	1	.....	.....	.....	.....	546,000	Jan. '08	.05
Free Coinage, g	Colo.	10,000	100	.....	.....	.....	.....	180,000	Dec. '09	1.00
Fremont Con., g	Calif.	200,000	2.50	.18	36,000	.....	.....	254,000	Oct. '14	.02
Frontier, z	Wis.	1,250	100	.....	.....	.....	.....	146,202	Nov. '12	2.00
Gemini-Keystone, g.s	Utah	5,000	100	15.00	75,000	.....	.....	2,305,000	Dec. '14	5.00

DIVIDENDS OF MINING COMPANIES IN THE UNITED STATES—Continued

COMPANY NAME	SITUATION	SHARES Issued	SHARES Par Value	DIVIDENDS PAID 1914 Per Share	1914 Total	1915 Per Share	1915 Total	To Date Total	Latest Date	Latest Amount
Golconda, g	Ariz.	850,000	$1	.....	.....	$0.20	$170,000	$ 170,000	Dec. '15	$0.10
Gold Coin of Victor, g	Colo.	1,000,000	1	.....	.....	.....	.....	1,350,000	Feb. '09	.02
Gold Dollar Con., g	Colo.	2,500,000	1	.....	.....	.....	.....	100,000	Dec. '12	.00½
Gold King Con., g	Colo.	1,000,000	1	.....	.....	.01	10,000	1,417,319	Nov. '15	.01
Gold Sovereign, g	Colo.	1,804,772	1	.....	.....	.....	.....	32,560	Nov. '12	.00½
Golden Cycle, g	Colo.	1,500,000	1	$0.67	$1,005,000	.38	570,000	4,170,000	Dec. '15	.02
Gold Chain, g	Utah	1,000,000	.....	.....	.....	.....	.....	130,000	May '13	.03
Gethin-LeRoy, l.s.	Utah	750,000	1	.....	.....	.....	.....	7,500	Nov. '13	.01
Golden Star, g	Ariz.	400,000	5	.....	.....	.....	.....	140,000	Mar. '10	.05
Goldfield Alamo, s.l	Nev.	700,000	1	.....	.....	.....	.....	42,000	May '10	.03
Goldfield Comb. Frac., g	Nev.	922,000	1	.....	.....	.....	.....	92,111	Nov. '09	.10
Goldfield Con., g	Nev.	3,558,367	10	.30	1,067,744	.45	1,601,617	28,999,832	Oct. '15	.10
Grand Central, g	Utah	500,000	1	.15	75,000	.02½	12,500	1,633,250	Dec. '15	.02½
Granite, g	Colo.	1,650,000	1	.....	.....	.....	.....	286,500	Dec. '12	.01
Hazel, g	Calif.	900,000	1	.....	.....	.....	.....	971,000	Dec. '13	.01
Hecla, l.s	Ida.	1,000,000	.25	.22	220,000	.56½	565,000	3,755,000	Dec. '15	.10
Hercules, l.s	Ida.	1,000,000	1	3.00	3,000,000	2.25	2,250,000	10,750,000	Dec. '15	.20
Homestake, g	S. D.	250,000	100	8.80	2,210,208	8.80	2,210,208	38,891,908	Dec. '15	1.65
Horn Silver, s.c.s.l	Utah	400,000	25	.....	.....	.....	.....	5,642,000	Sept. '07	.05
Insurgent, g	Wash.	100,000	1	.....	.....	.....	.....	25,000	Dec. '11	.12½
Iowa-Tiger, g.s.l	Colo.	3,000	1	2.00	6,000	.....	.....	9,250	Dec. '14	1.00
Iowa, g.s.l	Colo.	1,666,667	1	.00½	8,333	.01	16,667	270,167	Dec. '15	.00½
Iron Blossom, s.l.g	Utah	1,000,000	.10	.40	400,000	.38	380,000	2,555,000	Dec. '15	.08
Iron Silver, s.l.g	Colo.	500,000	20	.20	100,000	.20	100,000	5,050,000	Dec. '15	.20
Isle Royale, c	Mich.	150,000	25	.....	.....	.....	.....	150,000	Mar. '13	1.00
Iron Cap, pfd, c	Ariz.	25,215	10	.....	.....	.17½	4,414	4,414	Dec. '15	.17½
Jamison, g	Calif.	390,000	10	.....	.....	.....	.....	378,300	Jan. '11	.02
Jerry Johnson, g	Colo.	2,500,000	.10	.00½	12,500	.....	.....	187,500	Nov. '14	.00½
Jumbo Ext., g.s	Nev.	1,550,000	1	.05	62,500	.22½	333,750	493,408	Dec. '15	.10
Kendall, g	Mont.	500,000	5	.06	30,000	.....	.....	1,505,000	July '14	.06
Kennedy, g	Calif.	100,000	100	.....	.....	.....	.....	1,831,000	Apr. '10	.03
Jim Butler-Tonopah, g.s	Nev.	2,000,000	1	.....	.....	.10	200,000	200,000	Aug. '15	.10
King of Arizona, g	Ariz.	200,000	1	.....	.....	.....	.....	396,000	Aug. '09	.12
Klar-Piquette, s.l	Wis.	20,000	1	.....	.....	.....	.....	259,000	Apr. '13	.50
Kennecott, c	Alas.	250,000	10	4.00	1,000,000	.....	.....	5,000,000	Jan. '14	4.00
Knob Hill, g	Wash.	1,000,000	3	.....	.....	.....	.....	70,000	Oct. '13	.00½
Lake View, z	Utah	500,000	1	.004	2,000	.088	44,000	46,000	Dec. '15	.02½
Liberty Bell, g	Colo.	133,551	5	.50	66,776	.75	106,841	1,752,795	Sept. '15	.05
Linden, z	Wis.	1,020	10	.....	.....	11.00	11,220	11,220	Dec. '15	3.00
Little Bell, l.s	Utah	300,000	1	.....	.....	.....	.....	75,000	Mar. '11	.05
Little Florence, g	Nev.	1,000,000	1	.....	.....	.....	.....	430,000	Jan. '08	.03
Lost Packer, c	Ida.	150,000	5	.....	.....	.....	.....	37,500	Oct. '13	.25
Lower Mammoth, g.s.c	Utah	1,000,000	1	.....	.....	.01	10,000	67,000	Dec. '15	.01
Magma, c	Ariz.	240,000	5	.....	.....	1.00	240,000	240,000	Dec. '15	.50
Mammoth, g.s.c	Utah	400,000	25	.....	.....	.05	20,000	2,320,000	Dec. '15	.05
Manhattan-Big Four, g	Nev.	762,000	1	.....	.....	.....	.....	30,480	Aug. '11	.02
Mary McKinney, g	Colo.	1,309,252	1	.06	78,555	.....	.....	1,169,306	July '14	.02
Mary Murphy, g	Colo.	370,000	4.86	.05	18,500	.07	51,800	70,300	Dec. '15	.07
May Day, g.s.l	Utah	800,000	.25	.03	24,000	.11	88,000	244,000	Nov. '15	.03
Mexican, s	Nev.	201,600	2.50	.75	141,750	.....	.....	161,910	June '14	.75
Miami, c	Ariz.	747,113	5	1.50	1,120,463	2.25	1,681,004	5,399,878	Nov. '15	1.00
Mohawk, c	Mich.	100,000	25	1.00	100,000	3.00	300,000	3,575,000	Aug. '15	2.00
Monarch-Madonna, g.s.l	Colo.	1,000,000	1	.....	.....	.....	.....	40,000	Apr. '11	.01
Montana-Tonopah, s.g	Nev.	921,865	1	.....	.....	.....	.....	488,588	Dec. '12	.10
Mogollon Mines, g.s	N. M.	355,682	1	.....	.....	.15	53,352	53,352	Oct. '15	.10
Moscow M. & M., g.s.c.z	Utah	900,000	1	.03	27,000	.....	.....	67,480	Dec. '14	.03
Modoc, g.s	Colo.	500,000	1	.....	.....	.....	.....	275,000	Dec. '11	.01
Mountain, g.s	Calif.	250,000	25	.....	.....	.....	.....	4,216,250	May '08	.44
Napa Con., q	Calif.	100,000	7	.....	.....	.....	.....	1,840,000	July '11	.40
National, g	Nev.	750,000	1	.....	.....	.....	.....	570,000	May '11	.10
National Lead and Zinc, l.z	Mo.	500,000	1	.....	.....	.05	25,000	25,000	Dec. '15	.03
Nevada Con., c	Nev.	1,999,457	5	1.12½	2,249,389	1.50	3,099,185	19,976,159	Dec. '15	.50
Nevada Douglas, c	Nev.	1,000,000	5	.....	.....	.....	.....	125,000	Feb. '13	.12½
Nevada Hills, g	Nev.	1,065,558	5	.....	.....	.....	.....	373,000	Dec. '07	.02
Nevada Wonder, g.s	Nev.	1,482,860	1	.15	211,181	.10	140,829	643,558	Nov. '15	.05
New Century, z.l	Mo.	330,000	1	.....	.....	.....	.....	237,600	Oct. '09	.01
New Idria, q	Calif.	100,000	5	.10	10,000	1.50	150,000	1,830,000	Dec. '15	1.00
North Butte, c	Mont.	430,000	15	1.50	635,000	.90	387,000	12,077,000	Oct. '15	.50
North Star, g	Calif.	250,000	10	1.80	450,000	1.00	250,000	4,787,040	Dec. '15	1.40
Old Dominion M. & Sm., c	Ariz.	162,000	25	2.75	445,000	5.00	810,000	4,617,000	Dec. '15	2.00
Ophir, s.g	Nev.	201,600	3	.....	.....	.....	.....	2,068,360	Jan. '12	.10
Opohongo, g.s.l	Utah	898,978	.25	.....	.....	.....	.....	80,907	Jan. '13	.02
Optimo, z	Wis.	490	100	.....	.....	35.00	17,500	44,800	Sept. '15	10.00
Oroville Dredging, g	Calif.	700,000	5	.24	170,100	.36	312,080	1,849,108	Sept. '15	.12
Osceola, c	Mich.	96,150	25	3.00	288,450	7.50	721,125	12,900,800	Nov. '15	2.50
Osceola, l.z	Mo.	98,000	5	.....	.....	.....	.....	252,350	Oct. '12	.07½
Parrot, c	Mont.	229,850	10	.60	137,908	1.93	446,604	7,871,839	July '15	1.63
Pearl Con., g	Wash.	1,909,711	.....	.....	.....	.....	.....	181,422	Dec. '10	.02
Pharmacist, g	Colo.	1,500,000	1	.....	.....	.....	.....	87,500	Feb. '10	.01½
Pioneer, g	Alas.	5,000,000	1	.....	.....	.....	.....	2,041,526	Oct. '11	.03
Pittsburgh-Idaho, l	Ida.	809,407	1	.....	.....	.....	.....	217,083	Apr. '13	.04
Pittsburgh-Silver Peak, g	Nev.	2,790,000	1	.04	111,600	.....	.....	771,200	July '14	.02
Plymouth, g	Calif.	240,000	4.86	.....	.....	.72	175,560	175,560	Dec. '15	.24
Portland, g	Colo.	3,000,000	1	.12	360,000	.12	360,000	10,170,080	Dec. '15	.02
Prince Con. l.s	Utah	1,000,000	1	.....	.....	.12½	125,000	125,000	Dec. '15	.05
Quartette, g.s	Nev.	101,000	10	.....	.....	.....	.....	420,000	Sept. '07	.10
Quilp, g	Wash.	1,500,000	1	.....	.....	.....	.....	67,500	Feb. '12	.01
Quincy, c	Mich.	110,000	25	.50	55,000	8.00	880,000	21,777,500	Dec. '15	3.00
Ray Con., c	Ariz.	1,482,436	.....	1.12½	1,634,692	1.25	1,795,237	5,092,033	Dec. '15	.50
Republic, g	Wash.	1,000,000	1	.....	.....	.....	.....	170,000	Nov. '12	.01
Rochester, l.z	Mo.	4,900	100	.....	.....	.....	.....	190,846	July '12	.50
Round Mt., g	Nev.	1,266,591	1	.....	.....	.....	.....	363,365	Aug. '13	.04
St. Joseph, l	Mo.	1,464,798	10	.25	361,883	.60	845,643	10,197,413	Dec. '15	.25
Seven Tr. Coalition, g	Nev.	1,500,000	1	.....	.....	.10	144,301	180,380	Dec. '15	.02½
Shannon, c	Ariz.	300,000	10	.....	.....	.....	.....	750,000	Jan. '13	.50
Shattuck-Arizona, c	Ariz.	350,000	10	1.50	525,000	1.50	525,000	2,625,000	Aug. '15	.50
Silver King Coalition, l.s	Utah	1,250,000	5	.15	187,500	.45	562,500	3,097,385	Oct. '15	.15
Silver King Con., l.s	Utah	637,582	1	.40	251,032	.40	255,032	814,857	Dec. '15	.10
Sioux Con., l.s.g	Utah	746,389	1	.....	.....	.....	.....	872,105	July '11	.04
Skidoo, g	Calif.	1,000,000	5	.04	40,000	.....	.....	365,000	Oct. '14	.01
Snowstorm, c.g	Ida.	1,500,000	1	.....	.....	.....	.....	1,192,103	Oct. '13	.00½
Standard Con., g.s	Calif.	178,394	10	.....	.....	.....	.....	5,274,207	Nov. '13	.25
Stratton's Ind., g	Colo.	1,000,000	10	.03	30,375	.....	.....	456,625	Dec. '14	.03
Socorro, g	N. M.	377,300	5	.....	.....	.10	37,730	37,730	Dec. '15	.05
Success, z	Ida.	1,500,000	1	.....	.....	.47	705,000	1,050,000	Dec. '15	.03
Superior & Pitts, c	Ariz.	1,499,792	10	1.76	2,639,634	1.16	1,739,759	10,318,569	Dec. '15	.38
Stewart, s.l	Ida.	1,238,262	1	.60	742,956	.70	866,830	2,012,314	Dec. '15	.05
Tamarack, c	Mich.	60,000	25	.....	.....	.....	.....	9,420,000	July '07	4.00
Tennessee, c	Tenn.	200,000	25	2.25	450,000	3.00	600,000	4,906,250	Oct. '15	.75
Tomboy, g.s	Colo.	300,000	4.86	.96	301,320	.48	150,660	3,784,725	Dec. '15	.24
Tonopah-Belmont, s.g	Nev.	1,500,031	1	1.10	1,650,000	.50	750,016	7,643,019	Oct. '15	.12½
Tonopah Ext., g.s	Nev.	943,433	1	.25	224,858	.32½	306,613	967,015	Oct. '15	.07½
Tightner, g	Calif.	100	1,000	500.00	50,000	.....	.....	160,000	Jan. '14	500.00
Tonopah of Nev., s.g	Nev.	1,000,000	1	1.00	1,000,000	.90	900,000	13,000,000	Oct. '15	.15

DIVIDENDS OF MINING COMPANIES IN THE UNITED STATES—Continued

COMPANY NAME	SITUATION	SHARES Issued	SHARES Par Value	DIVIDENDS PAID 1914 Per Share	1914 Total	1915 Per Share	1915 Total	To Date Total	Latest Date	Latest Amount
Tri-Mountain, c	Mich.	100,000	$25	.....	.....	.....	.....	$1,450,000	Dec. '13	$2.00
Tuolumne, c	Mont.	800,000	1	.....	.....	.....	.....	520,000	May '13	.10
Tom Reed, g	Ariz.	909,555	1	$0.72	$654,756	$0.18	$154,624	2,443,757	Mar. '15	.06
Uncle Sam, g.s.l	Utah	500,000	1	.....	.....	.....	.....	470,000	Sept. '11	.05
United Copper, com	Mont.	450,000	100	.....	.....	.....	.....	5,962,500	Aug. '07	1.75
United Copper, pf	Mont.	50,000	100	.....	.....	.....	.....	1,500,000	May '07	3.00
United, s.l., com	Mo.	92,400	5	.....	.....	.....	.....	27,490	Oct. '08	.05
United, s.l., pf	Mo.	19,556	25	.....	.....	.....	.....	312,782	Jan. '08	.50
United (Crip. Ck.) g	Colo.	4,000,100	.....	.....	.....	.....	.....	440,435	Jan. '10	.04
United, c	Wash.	1,000,000	1	.....	.....	.....	.....	40,000	Nov. '12	.01
United Globe, c	Ariz.	23,000	100	26.00	598,000	27.00	621,000	2,576,000	Dec. '15	12.00
United Verde, c	Ariz.	300,000	10	3.75	1,125,000	6.00	1,800,000	36,397,000	Dec. '15	.75
Utah (Fish Springs), s.l	Utah	100,000	10	.....	.....	.....	.....	281,860	Dec. '10	.02
Utah Copper, c	Utah	2,797,182	10	3.00	4,827,924	4.25	6,904,082	32,711,896	Dec. '15	1.00
Utah Con., c	Utah	300,000	5	2.00	600,000	2.00	600,000	9,150,000	Dec. '15	.50
Utah-Apex, c	Utah	528,000	5	.....	.....	.12½	66,000	66,000	Oct. '15	.12½
Valley View, g	Colo.	1,000,000	1	.....	.....	.....	.....	240,000	Dec. '11	.04
Victoria, g.s.l	Utah	251,000	1	.....	.....	.....	.....	207,500	Mar. '10	.04
Vindicator Con., g	Colo.	1,500,000	1	.18	270,000	.15	225,000	3,262,500	Dec. '15	.03
Wasp No. 2, g	S. D	500,000	1	.06	30,000	.16½	82,500	549,466	Dec. '15	.01
Wellington, g	Colo.	10,000,000	1	.....	.....	.03	300,000	650,000	Nov. '15	.02
West End Con., g	Nev.	1,788,486	1	.15	268,273	.10	178,849	536,549	Dec. '15	.05
White Knob pfd., g	Calif.	200,000	10	.10	20,000	.40	80,000	100,000	Nov. '15	.10
Wilbert, l.s	Utah	1,000,000	1	.....	.....	.01	10,000	10,000	Nov. '15	.01
Wolverine & Ariz., c	Ariz.	118,675	5	.20	23,735	.25	53,423	23,735	Dec. '15	.20
Wolverine, c	Mich.	60,000	25	4.00	240,000	9.00	540,000	8,520,000	Oct. '15	5.00
Work, g	Colo.	1,500,000	1	.....	.....	.....	.....	172,500	July '08	1.00½
Yak, s.l	Colo.	1,000,000	1	.11	110,000	.16	160,000	2,007,685	Sept. '15	.03
Yankee Con., s.l.g	Utah	1,000,000	1	.....	.....	.....	.....	167,500	Jan. '13	.01
Yellow Aster, g	Calif.	100,000	10	.....	.....	.18	18,000	1,172,789	Dec. '15	.01
Yellow Pine, s.l.s	Nev.	1,000,000	1	.10	100,000	.45	450,000	893,088	Dec. '15	.15
Yosemite, g	Calif.	24,000	10	1.20	28,800	.....	.....	125,893	Dec. '14	.02
Yukon Gold, g	Alas.	3,500,000	5	.30	1,050,000	.30	1,050,000	7,672,000	Dec. '15	.07½
Total	.....	.....	.....	.....	$60,323,529	.....	$75,383,387	$884,222,042	.....	.....

IRON, INDUSTRIAL AND HOLDING COMPANIES

Amalgamated, c	Mont.	1,538,879	$100	$5.00	$8,079,115	$5.77	$13,318,995	$103,444,983	Aug. '15	$3.77
Am. Sm. & Ref., com	U. S.	500,000	100	4.00	2,000,000	4.00	2,000,000	27,333,333	Dec. '15	1.00
Am. Sm. & Ref., pf	U. S.	500,000	100	7.00	3,500,000	7.00	3,500,000	53,958,333	Dec. '15	1.00
Am. Smelters, pf. A	U. S.	168,300	100	6.00	1,020,000	6.00	1,009,800	10,529,800	Oct. '15	1.50
Am. Smelters, pf. B	U. S.	300,000	100	5.00	1,500,000	5.00	1,500,000	15,500,000	Oct. '15	1.25
Bethlehem Steel	Penn.	149,000	100	5.00	745,400	6.50	905,250	3,924,120	Oct. '15	1.75
Cambria Steel	Penn.	900,000	50	2.50	2,250,000	2.50	2,250,000	22,960,000	Nov. '15	.62½
Crucible Steel, pf	Penn.	244,365	100	3.50	855,275	1.75	427,638	19,261,451	Dec. '15	1.75
California Expl	.....	231,617	.....	.....	.....	.12	28,139	28,139	Oct. '15	.12
General Development	U. S.	29,988	100	3.00	89,964	4.50	134,946	2,993,910	Dec. '15	3.00
Great Nor. Ore	Minn.	1,500,000	100	.50	750,000	.50	750,000	11,250,000	Dec. '15	.50
Guggenheim Expl	U. S.	833,732	25	3.87½	3,222,969	3.75	3,123,100	23,323,327	Oct. '15	1.00
Inter'l Nickel, com	U. S.	379,253	100	10.00	3,803,150	27.50	10,654,028	25,500,466	Dec. '15	5.00
Intern'l Nickel, pf	U. S.	86,661	100	6.00	534,756	6.00	534,756	8,759,558	Nov. '15	1.50
Inland Steel	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Intern'l Sm. & Ref	U. S.	100,000	100	4.00	400,000	4.00	.....	.....	May '14	2.00
Lackawanna Steel, com	N. Y.	349,780	100	.....	.....	.....	.....	349,780	Jan. '13	1.00
National Lead, com	N. Y.	206,554	100	3.00	619,660	3.00	619,660	9,035,544	Dec. '15	.75
National Lead, pf	N. Y.	243,676	100	7.00	1,705,732	7.00	1,705,732	30,972,404	Dec. '15	1.75
Old Dominion, c	Ariz.	293,353	25	4.00	1,173,412	5.00	1,466,765	7,320,478	Dec. '15	2.00
Penn. Salt	Penn.	100,000	50	6.00	600,000	4.00	400,000	17,058,000	Oct. '15	1.00
Penn. Steel, pf	Penn.	165,000	100	.....	.....	.....	.....	13,201,000	Nov. '13	2.50
Phelps, Dodge & Co	U. S.	449,346	100	10.50	6,300,000	20.00	9,000,000	45,659,304	Dec. '15	5.50
Republic I. & S., pf	U. S.	204,169	100	5.25	1,171,788	2.00	408,338	15,731,183	Oct. '15	2.00
St. Mary's Min. Land	Mich.	160,000	25	.....	.....	8.00	1,280,000	6,520,000	Nov. '15	2.00
Sloss-Sheffield, com	Ala.	100,000	100	.....	.....	.....	.....	2,608,000	Dec. '10	1.25
Sloss-Sheffield, pf	Ala.	67,000	100	7.00	469,000	7.00	469,000 e	7,134,650	Nov. '15	1.75
U. S. Red. & Ref	Colo.	99,646	100	.....	.....	.....	.....	1,360,294	Oct. '07	.01
U. S. Steel Corp., pf	U. S.	3,602,811	100	7.00	25,219,677	7.00	25,219,677	395,513,014	Nov. '15	1.75
U. S. Steel Corp., com	U. S.	5,083,025	100	4.25	21,602,856	.....	.....	222,360,439	Dec. '14	1.25
U. S. Sm., Ref. & Min., com.	U. S.	351,073	50	2.25	789,995	.....	.....	6,362,181	July '14	.75
U. S. Sm., Ref. & Min., pf	U. S.	486,269	50	3.50	1,702,146	3.50	1,702,300	16,369,693	Oct. '15	.87½
Vulcan Detinning, pf	U. S.	15,000	100	.....	.....	.....	.....	1,155,000	Nov. '13	21.00
Warwick I. & S	U. S.	148,671	10	2.42	329,782	.70	104,070	1,422,468	Nov. '15	.35
White Knob C. & D., pf	.....	200,000	10	.....	.....	.40	80,000	80,000	Nov. '15	.10
Total	.....	.....	.....	.....	$90,434,677	.....	$82,592,194	$1,128,980,843	.....	.....

FOREIGN MINING COMPANIES

Amparo, g.s	Mex.	$2,000,000	$1	$0.14	$280,000	$0.06	$120,000	$1,640,883	Nov. '15	$0.03
Ajuchitlan, g.s	Mex.	50,000	5	.....	.....	.....	.....	212,500	Oct. '12	.25
Batopilas, g.s	Mex.	446,496	20	.....	.....	.....	.....	55,870	Dec. '07	.01½
Beaver Con., s	Ont.	2,000,000	1	.03	60,000	.06	120,000	589,879	Oct. '15	.06
Blanca y Anexas, s	Mex.	140,000	10	.90	63,000	.....	.....	1,943,000	Mar. '14	.90
B. C. Copper, c	B. C.	591,709	5	.....	.....	.....	.....	615,198	Jan. '13	.15
Buena Tierra, s.l	Mex.	330,000	4.86	.....	.....	.24	80,190	160,380	Dec. '14	.24
Buffalo, s	Ont.	1,000,000	1	.28	280,000	.....	.....	2,757,000	July '14	.05
Butter's Salvador, g	C. A.	150,000	4.86	.....	.....	1.08	164,025	3,966,075	Oct. '15	.24
Canadian Goldfields, g	Can.	600,000	.10	.002¾	110,000	.....	.....	290,000	July '14	.01½
Cananea Central, c	Mex.	600,000	10	.....	.....	.....	.....	2,913,020	July '12	.....
Caribou Cobalt, s	Ont.	1,000,000	1	.07½	75,000	.11½	115,000	215,000	Sept. '15	.09
Casey Cobalt, s	Ont.	244,950	4.86	.36	89,284	.....	.....	148,807	May '14	.12
Chontalpan, g.s.l.z	Mex.	7,000	.25	3.00	21,000	.....	.....	57,750	Apr. '14	.75
City of Cobalt, s	Ont.	1,500,000	1	.....	.....	.....	.....	139,385	Apr. '09	.03
Cobalt Central, s	Ont.	5,000,000	1	.....	.....	.....	.....	188,460	Aug. '09	.01
Cobalt Lake, s. d	Ont.	3,000,000	1	.05	150,000	.....	.....	465,000	May '14	.02½
Cobalt Lake (holding)	Can.	300,000	4.86	.24	145,800	.....	.....	328,050	May '14	.24
Coniagas, s	Ont.	800,000	5	1.50	1,200,000	.60	480,000	7,720,000	Aug. '15	.30
Crown Reserve, s	Ont.	1,768,814	1	.24	424,515	.06	106,129	6,067,032	July '15	.02
Cobalt Town Site, s.c	Ont.	199,282	4.86	.96	484,250	.....	.....	947,700	May '14	.48
Cobalt Town Site, s.d	Ont.	45,000	1	.45	200,000	.....	.....	1,042,259	Apr. '14	.10
Con. M. & S. of Can	Can.	58,052	100	8.00	464,352	8.00	464,352	2,175,005	Oct. '15	2.00
Dolores, g.s	Mex.	400,000	5	.....	.....	.....	.....	1,374,866	Jan. '11	.22½
Dos Estrellas, g.s	Mex.	300,000	.50	.....	.....	.....	.....	10,335,000	Dec. '13	1.50
Enciño y Anexas, s	Mex.	3,000	10	5.03½	15,105	.....	.....	30,105	Mar. '14	3.03½
El Favor, g	Mex.	3,500,000	1	.02	70,000	.....	.....	210,000	Apr. '14	.01
El Oro, g.s	Mex.	1,147,500	4.86	.....	.....	.....	.....	8,668,418	July '13	.24
El Rayo, g.s	Mex.	260,020	2	.....	.....	.....	.....	140,410	Apr. '11	.15
Dome, s	Ont.	500,000	5	.....	.....	1.00	500,000	500,000	Dec. '15	.50
Esperanza, s.g	Mex.	455,000	4.86	.24	115,425	.48	230,850	12,013,882	July '15	.24
Granby, s.l.c	B. C.	148,481	100	3.00	449,955	3.00	449,955	5,996,931	Nov. '15	1.50
Greene Cananea, c	Mex.	450,642	100	3.00	1,458,626	.....	.....	4,371,647	June '14	1.00
Greene Con., c	Mex.	1,000,000	10	1.00	1,000,000	.50	500,000	10,044,400	Dec. '15	.50

FOREIGN MINING COMPANIES—Continued

COMPANY NAME	SITUATION	SHARES Issued	SHARES Par Value	DIVIDENDS PAID 1914 Per Share	1914 Total	1915 Per Share	1915 Total	To Date Total	Latest Date	Latest Amount
Guanajuato D., pf., s.	Mex.	10,000	$100	.....	.....	.....	.....	$214,356	Jan. '10	$3.00
Hedley Gold	B. C.	120,000	10	$2.50	$300,000	$2.50	$300,000	1,824,000	Dec. '15	1.00
Hollinger, g	Ont.	600,000	1	1.95	1,170,000	2.60	1,560,000	4,170,000	Dec. '15	.20
Jimulco, c.s.	Mex.	10,000	100	.....	.....	.....	.....	1,055,000	Mar. '13	.01
Kerr Lake, s.	Ont.	600,000	5	1.00	600,000	1.00	600,000	6,120,000	Dec. '15	.25
La Rose Con., s.	Ont.	1,498,625	5	1.20	899,176	.60	499,588	5,424,587	Oct. '15	.05
Le Roi No. 2, g	B. C.	120,000	24.25	.....	.....	.48	58,320	1,530,900	Dec. '15	.24
Lucky Tiger Com., g	Mex.	715,337	10	.89	634,803	.69	493,583	3,263,391	Dec. '15	.09
McK.-Dar.-Sav., s.	Ont.	2,247,692	1	.21	472,014	.12	269,724	4,607,764	Oct. '15	.03
Mexican, l., pf.	Mex.	12,500	100	.....	.....	.....	.....	1,018,750	Oct. '14	.03
Mexico Mines of El Oro, g.s.	Mex.	180,000	4.86	1.92	349,920	.....	.....	4,458,745	June '14	.96
Min. Corp. of Can., s.	Ont.	2,075,000	1	.12½	259,375	.25	518,750	778,125	Sept. '15	.12½
Mines Co. of Am.	Mex.	838,628	10	.....	.....	.....	.....	4,958,600	July '13	.12½
Montezuma, l., pf.	Mex.	5,000	100	.....	.....	.....	.....	402,000	Nov. '12	3.50
N. Y. & Hond. Ros., g.	C. A.	200,000	10	1.20	240,000	1.60	240,000	3,790,000	Oct. '15	.40
Nipissing, s.	Ont.	1,200,000	5	1.25	1,500,000	1.00	1,200,000	13,590,000	Oct. '15	.25
Nova Scotia C. & S., com.	N. S.	60,000	100	4.50	270,000	.....	.....	4,440,000	July '14	1.50
Nova Scotia C. & S., pf.	N. S.	10,600	100	6.00	63,600	12.00	127,200	1,295,000	Dec. '15	12.00
Peñoles, s.l.g.	Mex.	120,000	15	.....	.....	.....	.....	6,361,687	June '13	1.50
Peregrina M. & M., pf.	Mex.	10,000	100	.....	.....	.....	.....	328,656	Sept. '10	3.50
Peterson Lake, s.	Ont.	5,600,000	1	.05¼	189,000	.05¼	189,000	378,000	Oct. '15	.01¾
Pinguico, pf., s.	Mex.	20,000	100	.....	.....	.....	.....	840,000	Oct. '13	3.00
Porcupine-Crown, g.	Ont.	2,000,000	1	.09	180,000	.12	240,000	420,000	Oct. '15	.03
Rambler-Caribou, c.	B. C.	17,500	100	.....	.....	.02	35,000	310,000	Dec. '15	.01
Right of Way Mines, s.	Ont.	1,685,500	1	.01	16,855	.....	.....	543,759	Nov. '14	.01
Rio Plata, s.	Mex.	373,437	5	.....	.....	.....	.....	345,745	Feb. '13	.05
San Rafael, g.s.	Mex.	2,400	25	.....	.....	.....	.....	1,442,380	Jan. '14	.50
Santa Gertrudis, g.s.	Mex.	1,368,000	4.86	.....	.....	.24	364,500	2,455,292	Nov. '15	.24
San Toy	Mex.	6,000,000	1	.....	.....	.....	.....	530,000	July '13	.01
Seneca-Superior, s.	Ont.	478,884	1	.70	335,218	.70	335,218	981,212	Dec. '15	.20
Sorpresa, g.s.	Mex.	19,200	20	.....	.....	.....	.....	3,979,240	Jan. '11	34.00
Standard, s.l.	B. C.	2,000,000	1	.23½	475,000	.12½	250,000	1,800,000	Dec. '15	.05
Temiskaming, s.	Ont.	2,500,000	1	.....	.....	.03	75,000	1,459,156	Dec. '15	.03
Tem. & Hud. Bay, s.	Ont.	7,761	1	9.00	69,849	.....	.....	1,940,250	Nov. '14	3.00
Tretheway, s.	Ont.	1,000,000	1	.05	50,000	.....	.....	1,061,998	July '14	.05
Wettlaufer-Lorrain, s.	Ont.	1,416,590	1	.....	.....	.....	.....	637,465	Oct. '13	.05
Total	.....	.....	.....	.....	$15,231,122	.....	$10,686,384	$177,340,970	.....	.....

a Two classes. *b* New series only. *c* Holding company. *d* Operating company. *e* 351,750 paid in scrip.

Data of the World's Principal Mines

By S. F. Shaw‡

Compiled from Annual Reports of the Respective Companies

Name of Mine	Situation	Year	Tons	Profit	Dividends	Reserves, Tons	Development, Feet	Yield per Ton	Cost per Ton
Ahmeek	U.S.	1914	590,519	$462,643	$200,356	.....	4,587	.....	$1.15
Alaska Mexican	Alas.-U.S	1914	233,457	170,020	144,020	688,736	4,555	$2.18	1.47*
Alaska Treadwell	Alas.	1914	910,285	1,351,403	1,100,000	7,159,253	6,604	2.62	1.49*
Alaska United	Alas.	1914	458,314	257,939	162,180	4,686,539	14,517	2.11	1.54*
Allouez	U.S.	1914	354,457	114,534	.....	.....	3,526	2.23	1.91
Amalgamated Zinc	Aus.	1st-1914	247,386	290,000	.....	.....	.....	.....	.....
		2d-1914	165,438	£34,356	.....	.....	.....	.....	.....
American Smelting and Refining	U.S.-Mex.	1914	1,266,702	9,031,565	8,017,450	.....	.....	.....	.....
Anaconda	U.S.	1914	.....	6,468,439	.....	.....	.....	8.94	.....
Arizona Copper	U.S.	'13-'14	1,079,950	£288,255	£157,521	.....	.....	4.86	3.56
Ashanti Goldfields	W.Af.	'13-'14	97,293	£145,731	£147,327	432,500	18,278	20.00	14.78
Associated Gold Mines	Aus.	'13-'14	127,856	£11,467	£12,384	33,306	.....	5.77	5.35
Baltic	U.S.	1914	324,433	154,233	.....	.....	.....	2.89	2.41
Blackwater	N.Z.	1914	50,426	£19,854	£12,499	104,564	.....	9.00	.....
Brakpan	Tran.	1914	622,573	£245,900	£225,000	2,490,000	24,389	6.70	4.79
British Broken Hill	Aus.	1914	28,512	—£17,610	.....	1,053,250	.....	.....	.....
British Columbia Copper	B.C.	1914	193,289	—39,765	.....	.....	2,576	.....	.....
Broken Hill North	Aus.	1st-1914	156,020	£157,658	£150,000	.....	.....	.....	4.33*
		2d-1914	102,735	£106,121	.....	3,000,000	.....	.....	.....
Broken Hill Block 10	Aus.	1st-1914	37,853	—£4,691	£12,500	.....	.....	7.35	.....
		2d-1914	23,810	£4,245	£10,000	.....	.....	8.49	7.64
Broken Hill Block 14	Aus.	1st-1914	19,821	—£608	£10,000	.....	.....	9.10	9.25
Broken Hill Proprietary	Aus.	1st-1914	139,991	£150,714	£107,050	.....	.....	.....	.....
		2d-1914	121,316	£125,611	£59,050	.....	.....	.....	.....
Broken Hill South	Aus.	1st-1914	172,178	£141,100	£140,000	.....	9,500	9.84	5.86
		2d-1914	112,750	£69,252	.....	.....	.....	6.34	4.90
Brunswick	U.S.	1914	16,237	123,964	94,869	21,000	.....	17.76	10.22
Buena Tierra	Mex.	1914	16,307	£5,908	£16,500	300,000	.....	6.90	5.14
Buffalo	Ont.	'13-'14	77,616	388,187	660,000	54,116	.....	.....	.....
Bullfinch Proprietary	Aus.	1913	52,679	£50,572	£47,615	145,582	.....	13.26	8.56
Butte & Superior	U.S.	1914	327,210	1,417,128	611,919	1,030,000	16,796	9.90	5.86
Calumet & Arizona	U.S.	1914	64,702	.....	.....	.....	6,328	.....	.....
Camp Bird	U.S.	'13-'14	30,595	£70,292	£45,500	25,709	.....	26.19	.....
Carn Brea & Tincroft	Eng.	1st-1914	29,795	—£3,681	.....	.....	.....	5.20	5.60
		2d-1914	29,373	—£283	.....	.....	.....	5.12	5.17
Centennial	U.S.	1914	138,136	—3,213	.....	.....	.....	2.01	2.08
Centennial Eureka	U.S.	1914	58,365	.....	.....	.....	.....	.....	.....
Champion	U.S.	1914	614,854	658,175	.....	.....	.....	3.44	2.31
Champion Reef	Ind.	'13-'14	216,934	.....	£138,667	477,384	17,334	11.45	.....
Chino	U.S.	1914	1,926,705	3,222,579	2,169,065	90,270,155	.....	3.76	2.11
City & Suburban	Tran.	1914	324,211	£248,550*	£204,000	758,700	10,965	8.79	5.06*
City Deep	Tran.	1914	505,800	£359,033	£296,875	2,510,800	.....	9.27	5.83
Coniagas	Ont.	'13-'14	54,522	989,618	.....	260,086	2,295	.....	.....
Cons. Langlaagte	Tran.	1914	578,100	£236,224	£190,000	2,220,707	.....	6.12	4.15
Cons. Main Reef	Tran.	'13-'14	241,257	£116,609	.....	693,460	.....	7.67	5.30
Cons. Mining and Smelting	B.C.	1914	374,771	474,012	464,376	.....	33,146	.....	.....
Copper Queen	U.S.	1914	732,829	.....	.....	.....	.....	.....	.....
Crown Mines	Tran.	1914	2,287,600	£990,573	£799,090	9,369,000	.....	6.32	4.22
Crown Reserve	Ont.	1914	31,635	239,447	425,515	.....	4,056	23.40	15.90
Daly-Judge	U.S.	1914	54,701	127,803	180,000	.....	11,559	.....	2.39
Davis-Daly Estate	U.S.	'13-'14	52,195	—108,020	.....	.....	.....	.....	.....

Note—Abbreviations used in above table: Alas., Alaska; Aus., Australia; B. C., British Columbia; Braz., Brazil; Can., Canada; Cap. Col., Cape Colony; Eng., British Isles (Cornwall); Hon., Honduras; Ind., India; Malay, Malay States; Mex., Mexico; N.S.W., New South Wales; N. Z. New Zealand; Port., Portugal; Rhod., Rhodesia; Sib., Siberia; S. A. South Africa; Tas., Tasmania; Tran., Transvaal; U. S., United States; W. Af., West Africa.
— Loss for the year. * Cubic yards. ½ First half. ½ Second half. All profits and dividends are in dollars except where otherwise noted.

† Superintendent, Charcas Unit, National Metallurgical Co., Charcas, S. L. P., Mex.

DATA OF THE WORLD'S PRINCIPAL MINES—(Continued)

Name of Mine	Situation	Year	Tons	Profit	Dividends	Reserves, Tons	Development, Feet	Yield per Ton	Cost per Ton
Detroit Copper	U.S.	1914	477,582	.....	280,000	.....	26,375	.....	.....
Dolcoath	Eng.	½–1914	57,254	£510	.....	.....	.....	5.73	5.73
		¾–1914	48,058	£898	.....	.....	.....	6.03	5.93
Dome	Ont.	'14–'15	248,550	315,179	.....	2,782,811	12,098	4.25	2.97*
Ducktown Sulphur and Copper	U.S.	1914	169,000	.....	£199,820	3,240,000	.....	.....	.....
Durban-Roodepoort	Tran.	1914	170,238	£36,341	£31,500	475,093	.....	5.12	3.99*
Durban-Roodepoort Deep	Tran.	1914	299,090	£57,237	£33,000	1,303,400	.....	6.62	5.69*
East Butte	U.S.	1914	110,992	222,252	.....	.....	.....	11.63	9.45
East Rand Proprietary	Tran.	1914	1,831,950	£736,157*	£428,032	5,400,000	.....	6.64	4.70*
Esperanza	Mex.	1914	120,975	319,967	157,500	200,000 tails 148,365	13,277	8.59	5.95
Federal Mining and Smelting	U.S.	1914	414,741	.....	599,305	1,037,090	7,256	.....	.....
Gaika Gold	Rhod.	'13–'14	36,927	£29,126	£27,349	100,770	.....	10.85	6.30
Geduld	Tran.	1914	244,385	£96,968	£46,125	1,900,000	.....	7.86	5.93*
Geldenhuis Deep	Tran.	1914	570,600	£129,096	£109,878	1,613,000	.....	6.66	5.55*
Globe & Phoenix	Rhod.	1914	.....	.....	£240,000	194,400	.....	.....	.....
Goldfield Consol	U.S.	1914	338,192	1,835,224	1,067,744	142,000	30,028	11.61	6.19
Gold Roads	U.S.	1914	107,846	.....	.....	.....	.....	.....	.....
Great Boulder Perseverance	Aus.	1914	245,555	£27,996	.....	595,007	.....	5.16	4.61
Great Boulder Proprietary	Aus.	1914	190,117	£300,632	£262,000	560,647	.....	13.40	6.77
Great Fingall	Aus.	1914	44,006	—£25,821	.....	63,360	.....	8.10	10.95
Greene Cananea	Mex.	1914	384,690	615,792	1,000,000	.....	31,859	10.00	8.41
Grenville	Eng.	¾–1914	21,483	£1,869	.....	.....	.....	6.08	6.50
		¾–1914	24,515	.....	.....	.....	.....	.....	.....
Hedley Gold	B.C.	1914	78,484	388,228	300,000	413,000	.....	10.16	5.21
Hollinger	Ont.	1914	208,936	1,786,679	1,170,000	.....	10,622	12.87	4.50
Homestake	U.S.	1914	1,587,774	.....	2,210,208	.....	.....	3.88	.....
Hornsilver	U.S.	1914	24,121	.....	.....	10,000	.....	.....	.....
Hutti Gold Mines	Ind.	1914	33,425	£11,081	£9,783	64,000	.....	11.71	10.10
Independence (Stratton's)	U.S.	'13–'14	.....	72,000	29,820	.....	2,311	.....	.....
Inspiration Con	U.S.	1914	172,722	.....	.....	97,143,000	102,066	.....	.....
Iron Blossom	U.S.	1914	40,480	306,150	400,000	.....	.....	$22.23	14.67
Iron Silver	U.S.	1914	52,490	174,629	100,000	.....	4,914	.....	.....
Isle Royale	U.S.	1914	474,349	24,374	.....	.....	9,919	.....	.....
Ivanhoe	Aus.	1914	218,420	.....	£105,000	998,718	.....	8.08	.....
Jumbo Extension	U.S.	'14–'15	16,420	339,373	125,317	86,750	.....	39.64	18.97
Kalgurli	Aus.	'13–'14	127,820	£101,330	£96,000	200,000	2,665	.....	4.69
Kerr Lake	Ont.	'13–'14	33,955	620,785	615,000	.....	.....	.....	.....
Knights Central	Tran.	1914	284,960	£42,752	.....	430,500	.....	5.39	4.64*
Knights Deep	Tran.	'13–'14	1,112,820	£135,865	£74,352	2,480,000	.....	3.52	2.94*
Lake View & Star	Aus.	'14–'15	218,124	£37,136*	£32,000	426,301	.....	5.69	4.80*
Langlaagte Estate	Tran.	1914	589,619	£156,054	.....	886,396	.....	5.91	4.62
La Rose	Ont.	1914	54,020	217,979	749,313	47,467	8,000	.....	.....
Le Roi No. 2	B.C.	'13–'14	26,679	£6,193	.....	.....	.....	.....	.....
Lena Goldfields	Sib.	'13–'14	.....	£50,558	£57,914	.....	.....	7.21	7.41
Liberty Bell	U.S.	1913	179,178	.....	.....	.....	5,662	5.44	3.95
Lonely Reef	Rhod.	1914	61,590	£48,005	£50,023	140,042	.....	14.69	11.21
Magna Copper	U.S.	'14–'15	44,075	.....	.....	95,000	12,311	.....	.....
Main Reef West	Tran.	'13–'14	212,852	£56,640	.....	526,440	.....	6.90	5.63
Mammoth	U.S.	1914	235,146	.....	.....	.....	.....	.....	.....
Mason & Barry	Spain	1914	259,238	.....	£27,775	.....	.....	.....	.....
Mason Valley	U.S.	1914	75,038	—40,274	.....	.....	1,995	.....	.....
Mass Copper	U.S.	1914	209,354	64,546	.....	1,250,000	2,760	.....	1.98
Meyer & Charlton	Tran.	1914	177,176	£207,608	£140,000	469,839	.....	11.42	5.73
Miami	U.S.	1914	1,096,633	.....	.....	36,500,000	22,865	4.04	2.87
Modderfontein B	Tran.	1914	440,100	£402,000	£385,000	2,772,500	.....	.....	.....
Montana-Tonopah	U.S.	'14–'15	63,754	.....	.....	.....	.....	.....	.....
Mount Boppy	Aus.	1914	70,059	£35,416	£14,325	199,559	.....	9.08	.....
Mount Elliott	Aus.	'13–'14	37,875	259,000	178,000	533,750	.....	.....	.....
Mt. Lyell	Tas.	½–1914	163,596	£61,954	£80,424	3,122,723	.....	8.85	7.00
Mt. Morgan	Aus.	'13–'14	303,428	£199,054	£200,000	3,125,000	.....	15.00	11.94
Mysore	Ind.	1914	304,375	£379,725	£350,750	1,014,000	26,249	14.36	7.98
Namaqua Copper	Cap.Col.	1914	35,021	£30,070	£23,582	80,875	.....	.....	.....
Nevada Con	U.S.	1914	2,640,294	716,977	2,249,389	41,020,296	.....	2.67	2.40
Nevada Wonder	U.S.	'13–'14	48,578	247,743	281,636	.....	4,126	14.47	4.65
New Goch	Tran.	1914	359,850	£124,580	.....	825,896	4,701	4.96	3.22*
New Heriot	Tran.	1914	154,228	£120,32 *	£74,750	588,315	.....	8.87	5.08*
New Idria	U.S.	1914	62,578	—45,014	10,000	.....	12,367	4.70	5.44
New York & Honduras Rosario	Hond.	1914	109,170	.....	329,814	418,978	15,700	11.36	8.34
New Kleinfontein	Tran.	1914	601,000	£272,942	£115,154	2,890,731	.....	6.48	4.27*
Nigel	Tran.	1914	141,400	£30,351	£16,732	150,400	9,866	7.29	6.25
Nipissing	Ont.	1914	80,037	1,578,715	1,380,000	225,474	12,148	.....	11.60
North Butte	U.S.	1914	337,415	358,215	635,000	.....	.....	.....	.....
North Star	U.S.	1914	107,250	560,115	450,000	.....	2,053	10.40	5.43
Nourse Deep	Tran.	'13–'14	539,800	£160,879	£155,216	2,443,700	.....	6.88	5.42
Nundydroog	Ind.	1914	89,950	£97,818	£99,050	164,800	.....	16.40	11.12
Old Dominion	U.S.	1914	129,213	.....	445,500	.....	15,665	.....	5.20
Ooregum	Ind.	1914	154,898	£149,272	£138,270	266,260	.....	11.52	6.83
Oriental Con	Chosen	'13–'14	301,162	622,780	644,780	822,500	32,378	5.50	3.68
Oroyo-Links	Aus.	1914	145,130	£14,416	£14,375	160,111	.....	5.24	4.76
Osceola	U.S.	1914	1,108,447	353,677	289,541	.....	4,836	1.77	1.45
Otavi	W.Af.	'13–'14	50,070	.....	.....	.....	.....	.....	.....
Ouro Preto	Braz.	1914	80,138	.....	.....	112,678	.....	6.94	.....
Plymouth Con	U.S.	1914	44,773	£221	.....	.....	.....	4.37	3.17
Poderosa	Chile	1914	5,206	£28,514	.....	2,740	.....	.....	.....
Portland	U.S.	1914	275,129	590,595	360,000	.....	15,592	6.91	4.80
Prestea Block A	W.Af.	1914	270,732	.....	.....	554,137	.....	7.65	6.82
Progress	N.Z.	1914	33,150	—£7,708	.....	80,000	.....	7.00	.....
Quincy	U.S.	1914	.....	205,593	55,000	.....	.....	.....	.....
Randfontein Central	Tran.	1914	686,330	£698,493	.....	2,493,924	.....	5.61	4.27
Ray Con	U.S.	1914	2,427,000	2,015,378	1,089,322	74,765,789	75,261	3.13	2.17
Rio Tinto	Spain	1914	.....	£899,939	£737,500	.....	.....	.....	.....
Robinson Deep	Tran.	'13–'14	619,140	£324,532	£275,000	1,533,000	.....	6.68	4.13*
Rooiberg Minerals	Tran.	'13–'14	11,422 tails 29,181 mine	£51,131	£31,500	20,097	.....	18.28	12.02
Rose Deep	Tran.	1914	48,230	44,931	.....	.....	4,707	6.00	5.06
Santa Gertrudis	Mex.	'13–'14	393,836	£126,627	.....	967,000	.....	.....	.....
Seoul Mining	Chosen	1914	74,550	.....	250,000	1,200,136	19,116	9.44	3.90*
Simmer & Jack Prop	Tran.	'13–'14	769,900	£322,678	£337,500	2,320,000	.....	5.00	3.00
Simmer Deep	Tran.	1914	643,000	£39,037	.....	1,429,000	.....	4.03	3.75*
Sons of Gwalia	Aus.	1914	160,963	£42,148	£48,750	.....	.....	6.55	6.29
South Crofty	Eng.	1914	69,342	£2,653	£4,375	.....	.....	5.53	5.00
South Kalgurli	Aus.	1914	116,179	£9,634	.....	165,146	5,036	5.75	5.35
St. John del Rey	Braz.	'14–'15	191,500	£144,092	£64,626	.....	.....	11.58	7.92
St. Joseph Lead Co	U.S.	1914	1,989,977	.....	258,390	.....	.....	.....	.....
Sudan Goldfield	S.Af.	1914	16,456	£20,000	.....	.....	.....	.....	.....
Sulphide Corporation	Aus.	'13–'14	209,074	£165,227	£200,000	.....	.....	.....	.....
Superior & Boston	U.S.	'13–'14	25,625	—15,982	.....	.....	5,424	11.38	.....
Superior & Pittsburg	U.S.	1914	485,796	.....	.....	.....	66,465	.....	.....
Talisman, Con	N.Z.	'13–'14	41,680	.....	£120,750	37,515	.....	26.14	13.78
Tamarack	U.S.	1914	57,440	—174,944	.....	.....	.....	2.39	5.44
Temiskaming	Ont.	1914	.....	81,422	.....	.....	.....	.....	.....
Tennessee Copper	U.S.	1914	485,057	751,893	600,000	.....	.....	.....	.....
Tharsis Sulphur and Copper	Spain	1914	501,037	.....	£156,250	.....	.....	.....	.....

DATA OF THE WORLD'S PRINCIPAL MINES—(Continued)

Name of Mine	Situation	Year	Tons	Profit	Dividends	Reserves, Tons	Development, Feet	Yield per Ton	Cost per Ton
Tomboy	U.S.	'13-'14	137,456	£325,890	£62,000	452,000	.....	$7.37	$5.07
Tom Reed	U.S.	'13-'14	48,100	.....	.....	.....	5,695	24.09	8.66
Tonopah Belmont	U.S.	'14-'15	181,424	1,456,698	1,462,504	226,921	.....	.....	6.88
Tonopah Extension	U.S.	'13-'14	58,022	80,399	.....	.....	16,091	10.63	9.25
Tonopah Mining	U.S.	'14-'15	147,261	.....	1,000,000	102,056	18,487	15.02	8.51
Trimountain	U.S.	1914	227,251	58,639	.....	.....	.....	2.43	2.22
Tronoh	Malay..	1914	442,394*	—£20,109	.....	.....	.....	1.53	1.75
United States Smelting, R. & M. Co	U.S.-Mex.	1914	.....	2,265,641	2,228,892	.....	.....	.....	.....
Utah Apex	U.S.	'13-'14	121,675	54,561	.....	.....	.....	.....	.....
Utah Consolidated	U.S.	1914	201,851	.....	.....	256,521	.....	.....	.....
Utah Copper	U.S.	1914	6,470,168	8,678,491	4,827,885	342,500,000	.....	2.51	1.58
Van Roi	B.C.	'13-'14	16,025	—£3,835	.....	.....	.....	.....	7.09
Van Ryn	Tran.	1914	483,090	£361,345	£299,223	1,692,349	.....	8.12	4.48
Village Deep	Tran.	1914	600,250	£289,062	£225,392	2,853,470	.....	6.78	4.45
Waihi	N.Z.	1914	183,405	£145,016	£99,181	753,358	.....	8.68	6.22*
Waihi Grand Jc	N.Z.	1914	185,720	£76,636	£57,656	173,000	.....	9.55	6.34
Wallaroo & Moonta	Aus.	1914	.....	£39,997	£24,000	.....	.....	.....	.....
Wanderer	Tran.	'13-'14	150,060	£1,789	.....	102,300	.....	2.39	2.42
Wasp No. 2	U.S.	1914	176,140	45,465	30,000	.....	.....	1.53	1.29
West Rand Cons	Tran.	1914	310,750	.....	.....	.....	.....	.....	5.89
Winona	U.S.	1914	123,339	.....	.....	.....	.....	.....	.....
Witwatersrand Deep	Tran.	1914	518,406	£251,168	£178,750	1,707,400	.....	6.36	3.99*
Witwatersrand Gold	Tran.	1914	503,350	£271,023	£234,812	1,221,879	.....	.....	3.24
Wolhuter	Tran.	'13-'14	382,700	£53,853	£107,500	999,400	15,410	6.08	4.47*
Wolverine	U.S.	'13-'14	182,127	81,075	.....	.....	625	2.66	2.21
Yuanmi	Aus.	'13-'14	50,094	.....	.....	.....	.....	.....	4.71
Yukon Gold	U.S.	1914	11,909,355*	1,184,819	1,050,000	.....	.....	.35	.26
Zinc Corporation	Aus.	1914	144,667	£129,398	£49,139	1,185,870	.....	.....	.....

* Working cost. † Cu.yd. — Loss for year.

Workmen's Compensation Laws of 1914 and 1915

If proof were needed of the rapid growth of the idea of compensation of workmen for injuries received in the course of employment as a substitute for the old liability acts, it would be found in Bulletin No. 185 of the Bureau of Labor Statistics of the United States Department of Labor. The bulletin presents the legislation for the years 1914 and 1915, together with amendments to a number of earlier laws.

The new laws of 1915 cover eight states: Colorado, Indiana, Maine, Montana, Oklahoma, Pennsylvania, Vermont and Wyoming, besides the Territories of Alaska and Hawaii. Also a Presidential order extended the Federal Compensation Act of 1908 to workmen engaged on or about the Government railway in Alaska. Thirty-one states and the territories of Alaska and Hawaii now have compensation laws. A Federal statute covers also about one-fourth of the civilian employees of the United States. All of this legislation has been enacted since 1908, and practically all of the existing legislation in the states since 1910.

Of the new laws of 1915, one, that of Wyoming, must be classed as a compulsory-insurance law, while those of Maryland and Oklahoma are compulsory-compensation laws. In the other states the law permits the employer to elect or reject the compensation act. In case he rejects it, however, he is deprived of the customary defenses under the liability laws.

Some of the newer laws have certain features that are of special interest and worthy of mention. The Oklahoma statute, for example, applies only to cases of nonfatal accidents, while in Wyoming all awards, whether for death or disability, are in the form of lump-sum payments arbitrarily fixed by the statute without regard to the earning capacity of the injured person. The Alaska statute also provides for lump-sum payments except for temporary disability. Legislation elsewhere has very generally provided for periodical payments graduated according to wage loss, and this method is favored by practically all authorities.

Of the new laws of 1915, the Wyoming act is the least liberal, the compensation for death being limited to funeral expenses of $50 and a maximum death benefit of $2,000. In comparison with this, the Colorado statute provides for a maximum of $2,500, while the maximum of the Alaska statute is $6,000. In cases of temporary disability the Colorado law is less liberal than any other, as it provides for no compensation for disabilities not extending beyond three weeks. In the statutes of other states, the waiting time has usually been fixed at one or two weeks, no state except Colorado fixing a longer period.

Special boards or commissions for administration continue to be preferred, the laws of Alaska and Wyoming being the only ones enacted during 1915 which do not have this provision. In Maine, Maryland, Oklahoma and Vermont the administrative authorities are given no powers other than those relating to the administration of the compensation acts. In Hawaii county boards with functions restricted to the compensation act are provided for. In Louisiana the law is administered by the courts.

The prevention of accidents, as well as compensation, is provided for in a number of the new laws. Thus the Industrial Commission of Colorado is charged not only with the administration of the compensation act, but also with the duty of factory and mine inspection, the enforcement of woman- and child-labor laws, and safety laws generally. Corresponding provisions are found also in the laws of Indiana and Montana.

The bulletin contains a comparative analysis of existing workmen's compensation laws in the form of a large folding chart. Notwithstanding the efforts that have been made to bring about uniformity in compensation legislation, a comparison of the laws of the 31 states that have thus far enacted compensation laws shows the widest diversity in the methods and amounts of compensation payments and the scope of the various laws. Amending legislation is in general of a liberalizing character, either including new disabilities, as occupational diseases, or increasing the disability allowances, or introducing other details.

Promise of future progress in compensation legislation is found in the provision for a commission in Utah for the purpose of drafting a compensation bill.

Bulletins 126 and 185 thus give a complete report on compensation insurance.

Metallurgy of Lead in 1915

By H. O. Hofman*

During the last year there was little change in the practice of smelting silver-lead ores as a whole, although a number of improvements were introduced at the 23 plants in operation in North America (*Eng. and Min. Journ.*, 1915, Vol. 99, p. 59) which, with 124 blast furnaces, have an annual capacity of over 7,000,000 tons of charge. In the treatment of nonargentiferous ores the introduction of the Newnam mechanical ore hearth marks a radical innovation that is bound to become a permanent improvement. The refining of lead bullion has gone on in the usual way. The European War has drawn into the armies many investigators, so that there is comparatively little to record from the laboratories which usually make a careful study of metallurgical reactions.

Lead Ore and Its Handling

It is not often that jamesonite occurs in sufficient quantity to form an ore, but this is the case (Raymond, *Eng. and Min. Journ.*, 1915, Vol. 99, p. 9) near Zimapan, Hidalgo, Mexico. Concentration tests of the ore with 8% Pb and 4% Sb have given an enriched product with 25% Pb and 15% Sb; and blast-roasting the concentrates in a Dwight-Lloyd machine has shown that the antimony and arsenic are readily oxidized and volatilized, leaving behind a sinter low in these elements, well-suited for smelting in the blast furnace with siliceous ores carrying precious metal.

The purchasing of ores, including that of lead, has received the attention it has needed for a long time in the publication by C. H. Fulton (Technical Paper 83, Bureau of Mines). While schedules have been frequently given out, rational analysis of the subject has not received the attention it deserves, considering its importance in connection with lead works which are largely custom smelteries.

Smelting in the Ore Hearth

The working of the ore hearth in the Mississippi Valley has become about as much standardized as that of the blast furnace in other parts of the country, but at every smeltery there is the complaint of hard and unsanitary work in spite of the improvements made to mitigate the evil. It remained for W. E. Newnam (*Bull.* of A. I. M. E., Oct., 1915, p. 2139) to make the radical departure from rabbling by hand to doing this mechanically, and thus not only overcome the disadvantages of hard and unsanitary labor, but improve the work in quality and quantity. The ordinary ore hearth, 4 to 5 ft. long, requires in 24 hr. six men, and treats about 7,000 lb. of galena concentrates. The Newnam 8-ft. hearth treats 2½ times the amount of ore, and while it demands the same number of men, the work is light, so that in hot weather the rate of production is the same as that during the winter.

In a test run of four weeks with a galena concentrate containing 72.5% Pb and 15.1% S, the Newnam 8-ft. hearth treated 13,179 lb. ore with 3.6% coke breeze. It collected in pig lead, 67.44%; in gray slag, 15.18%; and in dust and fume, 17.38% of the lead; and eliminated 87.9% of the sulphur of the ore. The corresponding figures for the 4-ft. ore hearth were: Ore treated, 509 lb., and coke breeze required, 8.8%. The lead recovered in the products was: Pig lead, 55%; gray slag, 16.2%; dust and fume, 28.5%. The sulphur eliminated was 80.6%. With a concentrate assaying 82% Pb and 11.2% S, the lead recovered with the Newnam ore hearth, in pig lead was 91.15%; in gray slag, 4.25%; and in dust and fume, 4.6%. Of the S content, 94.7% was driven off.

Smelting in the Blast Furnace

The smelting works of Salida, Colo., discussed by F. D. Weeks (*Bull.* of A. I. M. E., 1915, p. 1961) and those of El Paso, Texas, treated of by H. F. Easter (*op. cit.*, p. 1493), have many things in common, as have most blast-furnace plants of the country, but they have certain features that give each an individual character.

The smeltery of Salida was the first to install the Dwight-Lloyd sintering machines and has done considerable experimental work with them, in preparing the ore for the six blast furnaces of the plant which are still fed by hand. The cleaning of the lead bullion forms an interesting feature. The bullion is tapped from the lead well into pots holding 10 bars and transferred to hemispherical kettles of 30 tons' capacity; there it is stirred with compresesd air, drossed at 450° C., and the dross freed from adhering lead with a Howard press. Stirring is continued until the temperature has fallen to 360°, and the dross rising to the surface is skimmed. The temperature is now raised to 380° C., and dip samples are taken for assay. The temperature is then raised to 425° C. and the bullion siphoned into molds. By paying attention to the temperatures given, the dip samples upon assay give check results which show that the silver was uniformly distributed in the lead.

The character of the work at El Paso has changed greatly in recent years. Erected in 1886, burnt in 1900, and at once rebuilt, the smeltery was considered at that time a model plant. It has since undergone many changes, but one characteristic has remained the same—the unloading of ore by hand and the making up of ore beds with wheelbarrows. The earlier character of the smeltery of being a lead plant has also changed in that lead has become subsidiary to copper. The increase of the copper content of the lead charges has also had its influence upon the blast-furnace work and upon the handling of its products. Formerly the lead was removed from the 46x162-in. blast furnaces in the usual way through the lead well, and matte and slag were tapped together into slag pots and transferred to settling reverberatory furnaces, from which the slag was drawn into waste-slag pots and the matte tapped to be granulated. The high copper content of the blast-furnace charges has been the cause of the closing up of the lead well; hence lead, matte and slag are tapped together from the breast. The lead is collected in an oblong forehearth 2 ft. 6 in. by 9 ft. 2 in. and 2 ft. deep, lined with 4.5 in. of magnesite brick. Matte and slag overflow into a larger oil-fired hearth, 10 to 20 ft., from which slag overflows

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continuously and matte is tapped periodically into a ladle, to be hauled to the converting department. The experiences had with the settling of matte have been of great value. Two facts stand out clearly: Whenever one has to deal with ores which contain considerable amounts of blende, blast roasting leaves most of the zinc sulphide unchanged because its oxidation requires time. Zinc oxide in the ore may enter the slag, zinc sulphide does not. The sulphide is taken up to a certain extent by the matte, but most of it forms a muck which floats on the matte and cannot be tapped. A partial analysis gave: Insoluble, 66; Fe, 19; CaO, 3.4; Zn, 24.3; S, 21; Pb, 10; Cu, 4.6%. The other fact is that in a reverberatory settler, a copper blast-furnace slag in the presence of a leady copper matte takes up lead and silver, and leady copper matte in contact with lead takes up lead.

Regulation of Blast-Furnace Work

The top of the charge of lead blast furnace ought to be always cool. It has been noticed (W. C. Smith, *Eng. and Min. Journ.*, 1915, Vol. 100, No. 18) that in working up storage-battery residues, the top becomes hot. This is attributed to the presence of PbO_2, which is readily dissociated into PbO and O by heat; it gives up one molecule of oxygen near the throat and oxidizes ascending CO. Heating the residue before charging or diminishing the amount on the charge corrects the condition. Premature oxidation of the coke is prevented by W. D. Kilbourn (U. S. Pat. 1,148,782) by coating it with a fusible lead-bearing mixture. In normal work (*Min. Sc. Press*, 1915, Vol. 111, No. 94) the gas passing off the top of a charge does not contain over 0.5% vol. O; if this amount is exceeded the reduction in the furnace is insufficient. Another sign for the quality of the work is the lead content of matte and slag. With 12% lead in the matte and 0.5% in the slag, reduction is good.

In a pamphlet, "Metallurgical Smoke" (*Bull.* No. 24, Bureau of Mines), C. H. Fulton has discussed briefly the leading devices used in lead and copper smelteries for collecting flue dust. The Cottrell electric-precipitation process has been introduced in the lead department of the Consolidated Mining and Smelting Co., at Trail, B. C. (G. Guess, *Can. Min. Journ.*, 1915, Vol. 36, No. 37), in which 384 vertical pipes 12 in. in diameter handle 100,000 cu.ft. per minute of gas. The collected dust assays 70% Pb. Alice Hamilton, who prepared last year a monograph upon lead-poisoning in smelteries (United States Bureau of Labor Statistics, *Bull.* 141) has extended her investigation to the manufacture of storage batteries (United States Bureau of Labor Statistics, *Bull.* 165). Of the 7,400 men employed in 1912 in 12 American smelteries, 1,769 were lead-poisoned, while in England, of 2,400 men, only 56 were thus affected. In the manufacture of storage batteries there were afflicted in the United States 17.9% of the men engaged in the work, in Great Britain 3% and in Germany only 0.97%. These startling figures show how little attention has been paid in this country to removing dust and fume from the working places and enforcing cleanliness in general. The "Report of the Selby Smelter Commission," published as Bulletin 98 by the Bureau of Mines, contains much valuable original information on the effects of smelter smoke upon human beings, animals and vegetation. It deserves careful study.

Desilverization Methods

In the Parkes process, practical experience accompanied by pyrometric measurement has determined that the best results are obtained if the zinc-silver crust is removed from the kettle at about 535° C. In view of the research of Carpenter and Whitley, which showed, contrary to the earlier work of Petrenko, that there exists only a single chemical compound of zinc and silver, Zn_3Ag_2, freezing at 665° C., F. C. Newton (*Bull.* of A. I. M. E., 1915, p. 474) carried out experiments at the desilverizing works of Maurer, N. J., to form this compound. He stirred the zinc into the lead bullion heated to 750° C. and removed the crusts as quickly as they formed until the lead became too cool to allow skimming. He found that the silver content of a crust diminished as the temperature of the lead rose. The cause of this is to be sought in the dissolution of Zn_3Ag_2 in lead; for which no data are extant.

A recent investigation by J. C. J. Cunningham (*Zt. anorg. Chem.* 1914, Vol. 39, No. 48) shows that there exists an eutectic of PbO-CuO with 32% CuO, freezing at 698° C. This furnishes an explanation of the well-known fact that coppery litharge runs more freely than when the lead bullion is free from copper.

Metallurgy of Copper in 1915

By Lawrence Addicks*

The year 1915 proved as strange as its predecessor in the conditions of the copper industry. From great depression, with reduced outputs, lowered wages and almost no visible market, the year has seen a complete reversal to record productions, the highest wages ever paid and for wirebars a price level of which no producer can justly complain. The effect of such revolutionary changes in the financial foundation of the industry has naturally been to confine technical advances largely to the few great companies whose resources enable them to adopt for a term of years a policy independent of the exigencies of the moment.

Practically all the copper-producing plants of the country, excluding Mexico, are being operated at maximum capacity. The new International smeltery, at Miami, and that of the United Verde, at Clarkdale, have been successfully placed in operation. The real limit of attainable production is now refinery capacity. While some 3,000,000 lb. per month has been added to the Tacoma refinery and a net increase of at least 10,000,000 lb. will soon be in operation at Great Falls, the refineries at present are holding back the smelters and further refinery extensions may be looked for.

A most remarkable development in the practice of flotation has taken place during the year. It has not been confined to any particular type of apparatus. In many cases it has been found possible to dispense entirely with the use of acid, and the cheapest of the common oils have

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largely replaced the expensive chemicals used a year ago as froth-forming mediums. It is possible now to talk about tailings running as low as 0.1% copper in some cases, and concentrates running as high as 25% in copper are made from 2% ore. These great advances have come about through intelligent experimentation and attention to detail and, of course, can be obtained only with sulphide minerals. Fine grinding with its attendant expense is also predicated. Various schemes for coating oxidized minerals in such a way that they can be recovered by flotation are being tried out, but without notable success as yet.

Unfortunately the theory of flotation[1] has not kept pace with the practice, and the fact that no rigid application of physical law has as yet been adduced to cover the known facts has made much more difficult the disentangling of the complicated patent situation.

At the Anaconda plant, in line with the new policy of abolishing the so-called first-class ore and sending everything to the concentrator, at the same time taking advantage of the improved recovery obtainable by flotation, radical changes have been made in the concentrator equipment and the capacity of the mill has been brought up to 15,000 tons per day[2]. The jigs on the roll and Huntington-mill floors have given way to roughing tables producing concentrates and coarse tailings, which are reground[3] in Hardinge mills in closed circuit with Dorr simplex classifiers. The slime is then treated in Minerals Separation machines and Callow cells. The final tailings are to be made into brick. The flotation concentrates are sent to Dorr thickeners followed by Oliver filters, resulting in a product running 18% moisture.

One of the most remarkable results of the successful development of flotation has been the effect upon the whole scheme of metallurgical treatment. It is now possible, given a suitable ore, to make tailings lower in value than the slag resulting from smelting the same ore raw, so that even quite high-grade ores can be profitably crushed and concentrated. As the flotation concentrates are exceedingly fine, they must be either roasted and smelted in a reverberatory or sintered and smelted in a blast furnace, thereby adding the handicap of sintering to the already difficult situation in which the blast furnace finds itself, owing to the recent advances in reverberatory practice, thus lowering reverberatory costs.

Progress in Leaching and Ore Roasting

The marked success of flotation on sulphide ores and concentrator tailings has to all appearances definitely removed this particular field from leaching operations, and this has largely checked the work so generally under way a year ago. The 2,000-ton unit at Anaconda has successfully been placed in operation on stored tailings where there is likely to be some oxidation from exposure. At last accounts no marked advantage of either process—leaching or regrinding and floating—has been announced.

The large plant at Chuquicamata, Chile, has apparently been started with remarkable freedom from technical difficulties, cathode shipments now being regularly received in this country. The large-scale experiments at Douglas, Ariz., have been shut down on account of the flotation showing; the work done has been fully covered in recent technical papers[4]. At Lake Linden, where a large plant has been in course of construction, the work has been delayed. Some of the details of the process have been made public[5], however. The older processes using ammonia as a solvent of copper oxide have failed on account of losses of the expensive reagents used. A study of these losses has developed that their source is not so much leakage of volatile ammonia as absorption by fine sand or slimes, and this has been minimized by using sufficiently dilute solutions.

At Ajo, Ariz., large-scale experiments are still being carried on, the management being practically committed to a wet method of handling the immense oxidized overburden of the New Cornelia property. An outline of some of the earlier work done here has been published[6], but no definite statement of a finished process has been made. Some work is being done on both the Midland and Slater leaching cycles in several parts of the country by those interested in the exploitation of these processes.

At least for the time being, therefore, flotation has preempted the sulphide field, while leaching is making good with oxidized ores. On mixed sulphides and oxides no decision has been reached, but it will likely be a draw, individual cases depending upon precious-metal values and other local considerations. An excellent résumé of the work done on leaching copper ores up to the first of the year was presented to the International Engineering Congress at San Francisco[7].

There has been no new development in the field of roasting during the year. The large increase in the production of fine, wet and often clayey flotation concentrates has in many cases altered the character of the charge to be roasted and naturally increased the problem of dust recovery. One interesting experiment is being tried at the new International smeltery, at Miami, where the usual roaster dust chambers have been omitted entirely, Cottrell treaters being relied upon to recover the dust values.

Blast-Furnace and Reverberatory Smelting

The sweeping changes at Anaconda following a successful duplication on a trial furnace of the use of coal-dust firing and side charging inaugurated at Copper Cliff, have been completed, and the rebuilt furnaces are fulfilling all expectations. The net effect of the alteration is the change from a furnace 19x112 ft., smelting 240 tons of charge with a coal ratio of 4¼, to a furnace 25x144 ft., smelting 650 tons of charge with a coal ratio of 7. Now that efficient coal drying and grinding machines[8] are standard, the decision between coal and fuel oil rests chiefly upon the cost per British thermal unit theoretically obtainable, and oil will likely be displaced in several large installations. The advantages of side charging are of course applicable to a furnace burning either fuel. Most reverberatory plants have considerably modified their methods of dumping charges.

The marked developments in reverberatory practice have relegated the blast furnace rather to the background, but the latter is too firmly entrenched to be swept away easily, and the present situation should spur its champions on to new trials along the line of substituting fuel oil for

[1]Rickard, "Min. and Sci. Press," Vol. III, p. 385.
[2]"Anode," February, 1915.
[3]Mathewson, "Min. and Sci. Press," Vol. III, p. 312.
[4]Addicks, "Met. and Chem. Eng.," Vol. XIII, pp. 531 and 748.
[5]Benedict, U. S. Pat. 1,131,986.
[6]Ricketts, "Trans. American Electrochemical Society."
[7]Austin, paper No. 160.
[8]Mathewson, "Eng. and Min. Journ.," Vol. 100, p. 45.

coke and of delivering blister direct, which have been rather inconclusively worked out in the past. Those interested in sintering methods will naturally do all possible to help the blast furnace to regain its popularity. Perhaps the greatest opportunity for further improvement in either method of smelting lies in reducing the metal losses, which, in many cases, are now costing more than the smelting. A valuable contribution in this direction is a series of papers that recently appeared in the *Journal*[9]. The large research staffs now being maintained by some of the companies should be able to throw some light upon what seems to have been a neglected problem.

The only new development in converter practice is an indirect one, the 25x175-ft. furnace at Anaconda for re-treating converter slag. The proposed charge is 700 tons of slag and 350 tons of fine ore per day, the final slag going to waste. The results of this work should be very interesting as indicating what can be done in the way of slag cleaning by re-treatment.

Fume-Condensation Practice

But four commercial methods of recovering values in smeltery fumes are in favor, and there is much diversity of opinion as to the choice of these. Where local conditions make it profitable, the direct manufacture of sulphuric acid is undoubtedly indicated. This has been limited chiefly by the lack of a local market and by the fact that sulphuric acid cannot readily be thrown away without serious consequences of some kind. The logical use is in leaching oxidized ores, and as leaching practice improves this market will broaden. Acid is readily made from roaster gases, and Anaconda already produces 100 tons per day. Where the attitude of a neighboring farming community is hostile, the baghouse has much in its favor on account of the perfect ridding of the issuing gases of visible solids. The Cottrell apparatus has made great progress in the last few years, and it is now generally admitted that the early troubles with the original Balaklala installation were not due to any failure of the principles involved. The Garfield plant, where the converter fumes are "treated," has proved an entire technical success. On the other hand, where no legal questions are involved it is a debatable matter whether the additional recovery above well-designed dust chambers warrants the additional investment and operating cost, always remembering that there is a heavy treatment charge to apply to the foul sludge recovered. However, the fine dust from flotation concentrates and the possible elimination of chamber investment as being tried out at the International smelter already referred to (and any case where high silver values are present in the smoke) favor the Cottrell process.

Altogether, therefore, the dust chamber with suspended wires continues to find the most general favor, but much work in a variety of directions is in progress to develop a process whereby some actual revenue may be derived from the sulphur and other nonmetallic values in smelter smoke. Anyone interested in smoke damage should obtain the report of the Selby Smelter Commission[10].

Progress in Copper-Refining Methods

Work continues to be done upon improved methods of treating anode slimes. A new process[11] for eliminating the copper before furnacing has been successfully applied at the Raritan Copper Works. The slimes are filtered and then mixed with the theoretical quantity of strong sulphuric acid required to convert the copper into sulphate, the resulting mud being pumped into a steel basin 7x13 ft. and heated to a temperature below the point of fusion or of decomposition of $CuSO_4$. The copper is then leached with hot water as a nearly pure sulphate. More or less than the theoretical amount will not do.

An improvement in the electrolytic purification cycle has been worked out at the Chrome refinery[12]. Advantage is taken of the tendency of the liquor in an active electrolytic tank to stratify in respect to copper contents and in this way a solution leaner in copper than the average in the tank is drawn off for recovery of byproducts and elimination of impurities.

The data for the excellent evaporative efficiency shown by the Chrome waste-heat boilers have been published in detail[13]. This installation includes a combination of boilers, economizers, forced and induced draft and cold feed water preheated by admixture.

[9]Lathe, "Eng. and Min. Journ.," Vol. 100, pp. 215, 263 and 305.

[10]Holmes, Franklin and Gould, Bulletin 98, U. S. Bureau of Mines.

[11]Keller, U. S. Pat. 1,110,493.

[12]Pym and Green, U. S. Pat. 1,148,798.

[13]Brower, "Eng. and Min. Journ.," Vol. 99, p. 892.

Metallurgy of Zinc in 1915

By W. R. Ingalls

Conditions in the zinc-smelting industry of the United States in 1915 rendered dollars so easy to get by anybody who had smelting capacity that the attention of smelters was devoted chiefly to the making of spelter in any old way, there being neither need for making improvements nor time to spare on them. In the Kansas-Oklahoma region there was a reversion to primitive methods, for the reason that they were the easiest in the inauguration of new smelting capacity, haste being a prime consideration. Many of the smelters who repaired old plants are using the auger machines of 20 years ago for the manufacture of their retorts and are making condensers by hand. This is being done even in some important plants, with the result, it is said, that zinc extraction is not exceeding 80%, while there is an immense breakage of retorts and condensers, especially in the smelting of Rocky Mountain ores, some of which contain as much as 20% iron. These plants will be run only so long as the price for spelter is high and the smelting margin is large. When the price and margin shrink, their owners expect to quit the business, and in the meanwhile do not intend to spend any money on plant that is not absolutely necessary.

In general the zinc smelters of the United States who gave any thought to the excellence of their practice confined themselves to the improvement of details. Thus one

smelter reported better extraction of zinc from low-grade ore, not owing to the introduction of any novelty in practice, but simply to increased familiarity with the behavior of these low-grade ores and to the insistence of more careful work in the handling of the furnaces. Another smelter reported the introduction of several mechanical improvements that resulted in greater economy in the handling of material. Other smelters experimented with mechanical gas producers. The Edgar Zinc Co. continued its experiments with coal-dust firing, but as yet has achieved no great success with this. The United States Smelting Co. inaugurated an experiment for the collection of zinc dust by the use of prolongs on the condensers, a reversion to old practice that was abandoned in Kansas many years ago, but may be economical under existing conditions.

The Kansas-Oklahoma region was favored with a better supply of natural gas in 1915 than for a long time previous. This was due to some small concerns selling out and to the increased pumping of gas that could not be put into the high-pressure lines for distant delivery.

In the Kansas-Oklahoma region, the most important improvement in blende roasting is the lowering of the arch in the Zellweger furnaces, and in some instances the doubling of the furnace, the rabble being carried on the same shaft for the two furnaces. This, together with the lowering of the arch, saves fuel, the admission of unnecessary air being reduced. The original Zellweger furnaces were enormous wasters of fuel. With the recent improvements, they are still bad, but not so bad as they were.

At Argentine, Kan., the National Zinc Co. is building six Spirlet furnaces, which will be ready for operation early in 1916.

The Donora Smeltery

One of the important commercial features of 1915 was the expansion of the United States Steel Corporation—through its subsidiary, the Edgar Zinc Co.—in the zinc-smelting business. The new plans comprised the erection at Donora, Penn., of a plant designed for the smelting of 100,000 tons of zinc ore annually and the production of about 40,000 tons of spelter, the distilling equipment of the plant being about 9,000 retorts. In speed of construction all previous records were broken in this plant. Earth was first turned over about the end of June, and spelter was first made on Oct. 20. However, the plant will probably not be completed until about Mar. 31, 1916. Even that will be only about nine months from start to finish. Such a construction would ordinarily take 18 months. The Donora plant is unique in zinc-smelting construction, moreover, by reason of the extensive use of reinforced concrete in its several parts. About 50,000 cu.yd. of concrete was laid, whereof about 30,000 cu.yd. was reinforced concrete. The Donora plant comprises 6 Hegeler roasting furnaces and 10 Hegeler distilling furnaces, each of 912 retorts. It is considered likely that the Steel Corporation will later build a smeltery at Gary, Ind., or in the Illinois coal field.

Retort Discharging Machines

The United States Zinc Co. now has in operation at Sand Springs, Okla., six of the Simmonds discharging machines that were described a year ago. This means that the residues are being removed from six distillation furnaces with these machines, it having been found advisable to have one machine for each furnace in this type of smeltery. At Blende, Colo., there are two machines in operation, one taking care of one side of two furnaces. With a smeltery of this type, that is, with the furnaces end to end, one discharging machine can easily take care of one side of two furnaces. It is thought, moreover, that if a successful labor system can be devised, one discharging machine may be able to take care of one side of three or four furnaces.

At Blende the average time for removing the residues in the regular manner is 1 hr. 30 min. The machines do it in 20 to 23 min. At this plant the retort charge is often as much as 45 lb. per cu.ft., which is far in excess of the practice at other plants for a similar grade of ore.

Machines have been ordered to equip fully the Sand Springs plant, which consists of 14 furnaces, 400 retorts to the furnace. The Blende plant is to be fully equipped, after which an installation will be made at the plant of the Kusa Spelter Co., at Kusa, Okla.

The Grasselli Chemical Co. is also working on a retort discharging machine at Clarksburg, W. Va.

Zinc Refining by Redistillation

The extraordinary premiums that have been paid for high-grade and superior intermediate spelter led naturally to the refining of common spelter by redistillation. A large tonnage of refined spelter is now being produced in that way. There was no metallurgical novelty in this, a good deal of refined spelter having been so produced during many years by dross and junk smelters in this country and Great Britain, and also in Sweden and Norway, and perhaps elsewhere. The dross and junk smelters in this country commonly perform the redistillation in large retorts. The smelters in the Scandinavian countries do it in electric furnaces. The practice recently developed in the United States is novel in that the ordinary ore furnace is used for the purpose. Yet even that is novel only in the making of a regular practice of it.

The same thing was tried about 17 years ago in one of the works of the old Cherokee-Lanyon Spelter Co., then managed by A. B. Cockerill. Mr. Cockerill, who was something of an experimenter, thought then to improve his metal product by redistillation. He found that he could make a refined spelter assaying approximately 99.9% Zn, but he found also that he lost about 10% of his zinc in doing it (by absorption in retorts, breakage of retorts, failure to condense, etc.), and the premium realized for high-grade spelter at that time was not enough to pay for making it in this way. When, however, the premium rose to 10@15c. per lb., as it did recently, the aspect of things was changed radically.

Nevertheless there is some doubt as to just how much profit there is in refining spelter by this method under existing conditions, exceptional as they are. The slabs of common spelter are broken up or are recast in little bars, and are piled up in the ordinary retorts, which are heated in the ordinary way. The direct cost of redistillation is variously estimated at 0.5 to 1c. per lb., probably being nearer the lower figure than the higher. Then comes the cost of the zinc that is lost. This is variously stated at 10 to 12%—a confirmation of Mr. Cockerill's experience. If the common spelter that is being redistilled costs 10c. per lb., the loss is 1c. per lb. If it costs 20c. per lb., it is twice as much. The third element of cost is the use of smelting capacity. In normal times, when

there is a surplus, this might reasonably be reckoned as nil, but certainly not so at present, when smelting capacity is so urgently needed. An Iola furnace of 600 retorts is figured as taking about 30 tons of spelter per day for redistillation, or 60,000 lb. Such a furnace takes normally about 12½ tons of calamine or roasted blende. If the latter, say about 15 tons of raw blende. Now if the smelter can make a profit of $40 per ton in smelting ore (he talks about such figures), he does not make it if he uses his furnace for refining spelter, and such use may therefore be reckoned temporarily as costing him $600 per furnace per day, or 1c. per lb. The total cost of refining is therefore from 3 to 4c. per lb., which is not bad if a premium of 10c. be realized. However, there has been some difficulty in bringing all of the product up to the highest grade.

Electrolytic Zinc Production

Without any doubt, the most important thing in the metallurgy of zinc in 1915 was the inauguration of electrolytic zinc production direct from ore on a large experimental, even a commercial, scale at several places, the most important of these being at Anaconda, Mont., where the production of electrolytic spelter at the rate of about 5 tons per day was begun. The results are considered so favorable that the Anaconda company has commenced the erection at Great Falls, Mont., of a plant capable of producing 35,000 tons of electrolytic spelter per annum. With regard to the nature of the Anaconda process, Mr. Laist, who is responsible for it, has written me as follows:

> I can hardly claim that we have accomplished anything especially new in this line, except insofar as we have done on a somewhat larger scale what had often been done before by others in the laboratory and in a smaller way. Briefly, the process consists of concentrating the zinc ore, preferably by flotation, so as to make a concentrate with as little insoluble matter as possible and as rich in zinc as the nature of the ore allows. This concentrate is roasted in two of the furnaces of our copper-leaching plant, so as to produce a calcine containing from 2 to 3% sulphur, most of which is present as sulphate sulphur. The temperature is not allowed to exceed 1,350° F., under which conditions the formation of zinc ferrite is not pronounced.
>
> The calcine, after cooling, is treated with a solution containing sulphuric acid, which dissolves the zinc and a little of the iron. A small amount of manganese dioxide is added for the purpose of oxidizing the iron, which is then precipitated by means of a small amount of powdered limestone. Any arsenic or antimony is carried down by the precipitated ferric hydroxide. The resulting solution contains nothing but zinc, cadmium and copper, and is separated from the residue by filtration. The residue contains the lead, silver and gold and part of the copper originally present. The solution is treated with metallic zinc to precipitate the copper and cadmium, and is then pumped through a clarifying filter-press into a storage tank, from which it goes to the electrolytic cells. The cell room contains 42 tanks, which are in no way different from those commonly used for copper refining. Here the zinc is deposited on aluminum plates.
>
> The solution from the cells contains sulphuric acid and is used for leaching a fresh charge. The zinc deposits on the aluminum plates are stripped off every 48 hr. and sent to the melting furnace. At the present time we are making about five tons of zinc per day of a high degree of purity.

The Anaconda spelter assays above 99.9% Zn. It is well known that the electrolytic spelter produced for many years at Winnington, England, is guaranteed 99.95% Zn. I have often expressed the opinion that there was no great promise in a hydrometallurgical-electrometallurgical process of zinc extraction unless use could be made of the anode reaction (as at Winnington) or some specially favorable conditions otherwise might be found to exist. That appears to be the case with the Butte ore. In roasting there is relatively little formation of zinc ferrite, and consequently zinc extraction is high. Moreover, the ore is rich in silver, whereof 90% or so ought to be recovered by this process against only 65 to 70% by the pyrometallurgical process. Both of these are strong points. Of course, with existing commercial conditions, electrolytic zinc may be produced profitably out of many ores. However, the Anaconda metallurgists are of the opinion that they can carry on the process successfully under normal conditions.

Electrolytic zinc was also produced in 1915 on a commercial scale by the Weedon Mining Co., at Welland, Ont. There may also have been a small production elsewhere. R. G. Hall was understood to be experimenting in this line at Keokuk, Ia., and there were one or two other operations that may not yet be mentioned publicly.

Apart from the Anaconda work, the most ambitious plans were those of the Consolidated Mining and Smelting Co. of Canada, which continued the experimental work begun several years ago. In the last official report of this company it is stated that spelter of good grade has been produced at the rate of 1,000 lb. per day from ore from the Sullivan mine, and that the results were sufficiently promising to warrant the building of a plant capable of producing 25 to 35 tons of spelter daily. Construction of this plant is well advanced, and it is expected to be in operation early in 1916.

Metallurgy of Gold and Silver

By Herbert A. Megraw

New steps in the metallurgy of gold and silver have been few during the last year. It has been a most uncommonly sterile period as regards metallurgical advances. Some new plants have been built, but in none of them has any serious new development of metallurgy been incorporated. The principal plants of this continent have been satisfied to continue in the regular way, applying principles of efficiency to processes already developed, but spending little time on any new features.

The production of gold has been stimulated by war conditions, through its requirement for the liquidation of the world's indebtedness. For this reason gold mines have been worked to the limit of their possibilities, and even new mines have been opened and pushed toward the productive stage. In silver, however, the situation has been somewhat different. There has been little demand for the metal through financial sources, and the price has until recently remained at a low point. This situation made the conditions of silver producers rather hard to endure for a long time. Many of the weaker operators had to restrict operations or discontinue entirely. During the last month or two of 1915 the price of silver took an upward trend, however, and almost immediately established itself at a comfortably high level. This is said to be due to buying from the Orient, but the result is satisfactory to the producer, whatever the cause.

The basic conditions attending the distribution of gold and silver have been, as has just been mentioned, in such a condition as to stimulate, in the case of gold, maximum production and to deter, in the case of silver, overproduction, the result in either case being a hesitation to attempt metallurgical changes of any kind. With gold the conditions required its production at maximum rate, leaving no time for experiments; while with silver the result was the same, although for the reason that profits had been much reduced in the business and there was no disposition to spend money on metallurgical changes.

Progress During the Year in Mexico

Conditions in Mexico have been pretty much the same as during 1914. At the beginning of the year an improvement seemed to be about to set in, but toward the last quarter everything was again disarranged. During the part of the year that operations were possible, a number of the larger plants made more money than they did in normal times. This situation came about through the general lack of employment for laborers. These people then went to work on their own hook and instituted an industry of cleaning and sorting ore from old dumps, mining on their own account and in many cases robbing the best ore from mines belonging to foreigners that had left the country. The ore thus produced was sold to operating companies at an extremely low price, and those companies having the necessary supplies for milling it and the facilities for getting the bullion out of the country increased their earnings through this practice. At the end of the year, however, about everything was shut down, since supplies could not be obtained nor was bullion safe from confiscation by any official that happened to be handy.

The rolling stock of all the railroads has practically ceased to exist, and now, even counting upon the best of intentions, it will be a long time before any serious operations can be carried on. While rolling stock may be imported promptly provided there is money to pay for it, it will not be so easy to put the roadbed in such condition that trains may be operated over it. Three years of almost complete inattention have made serious inroads upon its physical state. It is probable that considerable time and much labor will be required to put the railroads in condition to establish a satisfactory basis for the industries of the country.

All the principal camps in Mexico have suspended operations. At El Oro it was found impossible to secure supplies in such quantities as to guarantee continuous operations, so the plants were all closed. The same is true in Pachuca, where strenuous efforts were made to operate for a time, but it was found impossible. Guanajuato gave up the effort a long time ago, and there has been no attempt at regular operations. The Jalisco properties also suspended, as did most of those of the west coast, and in fact all large works in Mexico with the exception of a few near the United States border. El Tigre has been operating most of the time, and Batopilas operated a part of the year, but had to shut down in September. Naturally, nothing new in metallurgy has been developed in Mexico. Conditions have been too strenuous for any research work to be undertaken.

The Central and South American plants producing silver and gold have been pushed strongly during the year, but new developments have been rather commercial than technical. In no known case has any new departure in treatment methods been instituted, but full attention has been given entirely to mechanical and commercial improvements.

In this connection it is of some interest to say that aluminum precipitation from cyanide solutions has been receiving some additional attention during the year. The process was somewhat criticized by G. H. Clevenger in the early part of the year and was discussed again by E. M. Hamilton, who successfully instituted the process at the Nipissing mill at Cobalt. Aluminum precipitation has been established at the Butters plants in San Salvador, the San Sebastian and the Devisadero. It can hardly be doubted that aluminum precipitation is a satisfactory advance and is perfectly sure of its position in cases where its appropriateness has been indicated.

The New Tough-Oakes Cyanide Mill

In the Canadian field developments have been greater than almost anywhere else. At Kirkland Lake, the Tough-Oakes mill, a highly developed cyanide plant for handling rich gold ore, was completed. This is probably the most important plant finished and operated during the year. It certainly embodies the results of the most advanced technical study. The Tough-Oakes is a 100-ton all-slime cyanide plant, in which a ball mill replaces stamps. In this case a ball mill of the Hardinge type is installed, the product of which goes to two Dorr classifiers, each operating in closed circuit with a 5x20-ft. tube mill. Provision is made for the introduction of copper amalgamating plates should that at any time be considered necessary.

The slimes from the Dorr classifiers go to a thickener, the overflow of which is clarified and precipitated. The pulp is sent to Dorr agitators and a series of continuous counter-current thickeners. Transfers of thickened pulp are effected by diaphragm pumps. From the final tank the thickened pulp is discharged by a spigot into a launder, whence it runs through a mechanical-sampling device and then to waste. It will be noticed that in this plant the newest developments of cyanide metallurgy are incorporated.

The elimination of stamps from the metallurgical layout is a feature that is becoming increasingly frequent during the last few years, and one that will probably become the rule in the future. Continuous pulp-flow and automatic transfer of pulp in solution is another feature of the mill. The elimination of the slime filter for the tailings is a feature of importance. The mill design was under charge of the Butters-Johnston Engineering Syndicate.

At Cobalt a new slimes plant was built and operations begun, this being designed to handle the slime pulps from a coalition of several of the Cobalt concentrating plants. Operations have been successful up to the present time. These are about the only new developments in the Cobalt field. There has been considerable prospecting in the outlying silver districts, but as yet no discovery of great importance has come to light.

The Work of the Porcupine Districts

In Canada, in the Porcupine district, the Hollinger plant has increased its capacity and still another increase is under consideration. Hollinger, when taken together with its allied property, the Acme, is rapidly becoming

one of the great gold mines of the world and is now probably the principal one in Canada. The metallurgy at the Hollinger mill has not been changed; it is still making use of the modified system of counter-current decantation, together with filtration of part of the residue. Stamp crushing has always been considered satisfactory at the Hollinger, and no change has been made in it. Production is continuous on a large scale.

At the Dome, conditions have been improving during the year. The opening of a new and richer orebody was reported some time ago, and further plant improvements have been undertaken. No change in the metallurgy, however, is under consideration, the system continuing to be stamp crushing, regrinding in tube mills and separate treatment of sand and slime. The plant was appreciably enlarged in 1914, and further enlargement is being considered. Dome has been rather unfortunate in that the irregular quality of its ore deposits is responsible for the impossibility of maintaining a uniform milling system.

In other parts of Canada there is little of importance to record. In British Columbia the plants are proceeding about in the usual manner, with no new developments to report. All the properties are producing as best they can.

Developments on the Rand

On the Rand the practice has been absolutely normal, but production has been pushed to the utmost limit. Because gold has been so strongly in demand to pay the debts of the nation, practically all gold mines have been made to produce to the limit of their ability. Those in South Africa, are no exception to the rule, but, rather to the contrary, have been more strongly urged than have other places, since the Rand mines form such an important part of Great Britain's gold production. At the Rand mines there have been no delays due to strikes or other troubles, and the Rand output in general will probably be a record, at any rate, in the number of tons treated. The total output will probably not be so high as in other years, owing to the lower unit content of gold.

The question of cyanide supply has been less in evidence than was expected in the early part of the year. The production of American and British factories has been increased as far as possible, and it seems that a sufficient supply has been forthcoming to keep operating plants going. Perhaps the diminished demand from Mexico has been an important factor, since that country in normal times consumes more cyanide than the United States, but the fact remains that, although its source has not been a general subject of conversation, enough cyanide has been forthcoming to fulfill the actual necessities of all the large operating plants. I have not heard of any plant anywhere that had to shut down through inability to buy cyanide. So far as I know, there have been no entirely new producers of cyanide. It will be remembered that early in 1915 several new sources of cyanide were suggested. These factories have from time to time recorded some progress toward fitting themselves to turn out the material, but as yet none of them has succeeded in doing it.

In the United States production has been continuous and constant, but new details in metallurgy, as is the case everywhere else, have been conspicuous by their absence. A few new mills have been completed and some of the old ones somewhat changed, but nothing of great metallurgical interest has taken place. The Amador Consolidated milling plant, at Amador City, Calif., was started in May, a change of milling practice having been instituted. The mill contains twenty 1,000-lb. stamps, and to these were added two 8-ft. by 36-in. Hardinge mills. The capacity of the plant has been increased to 300 tons daily, and the processes in use include amalgamation, concentration and cyaniding. A description of this mill was published in the *Journal* of Aug. 14, 1915, a flow sheet of the complete practice being shown. Perhaps one of the most important features of the mill is its precipitation department. Zinc shavings were used at the outset, but, owing to erratic results, a change was made and zinc dust installed. The method followed is the same as that used at the Ajax property, of Victor, Colo. Two five-ton tanks are used, equipped with mechanical agitators, into which the solution from the gold tank is run. When the tank is about two-thirds full, the amount required of lead acetate and zinc dust is added, and by the time the tank is full it has had sufficient agitation and is then pumped through the filters. While one tank is being pumped out, the other is being filled and agitated. This system is said to be more satisfactory and economical from every standpoint than was the zinc-shaving system.

In Colorado, the Tomboy added a cyanide plant to its 60-stamp concentration mill and has materially increased its output. In Nevada a new mill has been constructed at the Elko Prince, this plant having been designed by the Dorr interests and including all-sliming, agitation and continuous counter-current decantation.

At Tonopah all the mills have been running and production has been about as usual. So far as can be determined at the present time, there have been no notable metallurgical extensions or improvements in the camp. All interest has been devoted to steady work and the systematization of well-known processes. Goldfield also has been producing about as usual, but this company has installed a tailings reclaimer and made arrangements to re-treat the accumulation of tailings below the mill. Much of these tailings were made while extremely high-grade ore was being treated in the mill, and it is believed that a large part of them can be treated again at a profit. It is stated that the company is trying out a process of flotation, and it seems that the prospects are favorable for its installation in the mill. It will be likely to add considerably to the output.

Arizona and Colorado Developments

A new spasm of interest is attaching to the Gold Road-Tom Reed district in Arizona. Aside from the Gold Road property and the Tom Reed, which have both been working profitably for a number of years, exploration has developed in the district a number of other properties that seem to be in the way of making substantial successes. Several of them are already paying largely in dividends, and it is hoped that the camp will become one of the large gold producers of the West.

In the Cripple Creek district there has been practically no new metallurgy except experiments on flotation. The feat of the year was the purchase of the Independence by the Portland Co. Some operators go so far as to say that flotation will open up a new era of profit in the camp and that it will more than double its former output.

In the Black Hills all the companies have been working as usual, including the Homestake, but there have been no changes of a metallurgical nature.

Flotation is the great puzzle of the year. Many operators believe it will take the place of practically all the wet-milling systems in use at the present time; but while this can probably be accepted with some reserve, it is nevertheless undoubtedly true that the cyanide operator would do well to transfer his affections to flotation and learn the business as thoroughly as possible. It is not going to eliminate the cyanide process altogether, but in the cases of ores of a certain character, it will surely lead to such increased efficiency for concentration systems that there will be no room for cyanide plants. Particularly apt, under present conditions, is the application of flotation to the silver-sulphide ores that form the greatest source of silver in the western United States and all of Mexico and Central America. With these ores concentration will become the principal metallurgical procedure, cyanide becoming an auxiliary used for treating the concentrates where conditions are not advantageous for shipping.

Progress of Flotation in 1915

By Herbert A. Megraw

During 1915 the flotation process was hampered by the status of the litigation over basic patents, just as it was in the year previous. The spread of the process has been so rapid, however, that by sheer weight of merit some of the important data regarding operating methods and conditions have broken through the reserve. Articles have appeared in the technical press setting forth the aims and objects of the process, and some of them have contained records from practice. A good many flotation articles, however, have been written without conveying much real information.

Important Facts Made Public

Probably the most important article of the year was that by J. M. Callow, read before a meeting of the Salt Lake section of the American Institute of Mining Engineers and to be presented at the February meeting of the institute at New York. This article was abstracted in the *Journal* of Dec. 4, 1915, and gave a good many facts about the establishment of the Callow system of flotation at several different mills, presenting flow sheets of the mills themselves, facts concerning their operation and an explanation of some of the theoretical bases of the process.

Other important articles appearing during the year were a description of the Silver Peak mill, of Australia, which appeared in the *Journal*,[1] and also Mueller's[2] experiments on the use of coal tar as a flotation oil. Concerning the use of oils in particular, it is hoped that the current year will bring forth some actual experimental data, since that is the point that has been particularly kept under cover up to this time.

As an auxiliary metallurgical process flotation seems to be succeeding in filling a niche that has been left absolutely vacant up to this time. Attempts to fill it through slime-concentrating machines have not been particularly successful, hence the stampede to make use of flotation, which promises a signal success at that point. There is enormous danger, however, that the universal adoption of the process, even for a specific purpose, is likely to degenerate into its adoption for all purposes and, through failure, to react upon the process in a way that will be to its disadvantage. Some of its enthusiastic adherents are recommending its use where success cannot possibly result. One or two failures will be more than likely to delay proper application.

To say that flotation may be the sole process of metallurgy in a given case is to make a statement entirely too broad for general credence. Some ores, it is true, may be treated exclusively by flotation, but it is reasonably certain that such ores are limited in number and that the statement can by no means be made a widely applicable rule. Ores that are of a coarsely crystalline nature can best be treated by stage crushing and stage concentration, beginning with jigging. By this means a large amount of expensive grinding and regrinding is avoided, and concentrates are recovered as quickly as possible. Of course, in such case the very finely divided part of the ore, or slimes, had best be treated by flotation, but with an ore of this character there is no reason for doing any more grinding than is just enough to liberate the mineral particles and allow them to be separated from the gangue. In fact, it may be said that this particular point is exactly the one that limits the reasonable application of flotation and other concentrating systems. The mineral particles must be liberated from the gangue by crushing, and then separated by concentration. Therefore crushing should be carried only far enough to liberate these particles, and the concentration process then applied to separate one from the other should be appropriate to the size of the grain thus freed. If the grains are all coarse, then under ordinary circumstances, jigging, table concentration or any form of ordinary gravity concentration is the one that should be applied. If the grains are exceedingly fine, then flotation will do the better work and at a lower cost. Of course it may be possible that in special instances, such as with very heavy gangues approximating the weight of the mineral itself, fine grinding and flotation will have to be resorted to in order to get satisfactory results, no matter what the size of the mineral grains are.

In general, when the ratio of concentration is low, it is considered better practice to begin with gravity concentration and finish up with flotation. When the concentration ratio is high, authorities consider it better practice to make flotation the principal process, with gravity concentration as an auxiliary. In cases where new and modern concentration mills have been constructed, based on gravity practice, it would be foolish to waste all the money involved in the work, and the part of wisdom is to use flotation as an auxiliary to the gravity-concentration scheme.

Up to the present time it may be said that any kind of an ore in which the mineral occurs in sulphide form

[1] "Eng. and Min. Journ.," Dec. 11, 1915.
[2] "Eng. and Min. Journ.," Oct. 9, 1915.

is susceptible to flotation. As yet there has been no great success in concentrating oxides by flotation, though some experimental successes have been obtained by chemically coating the oxide particles with a film of sulphide and then treating the coated oxide particles by flotation.

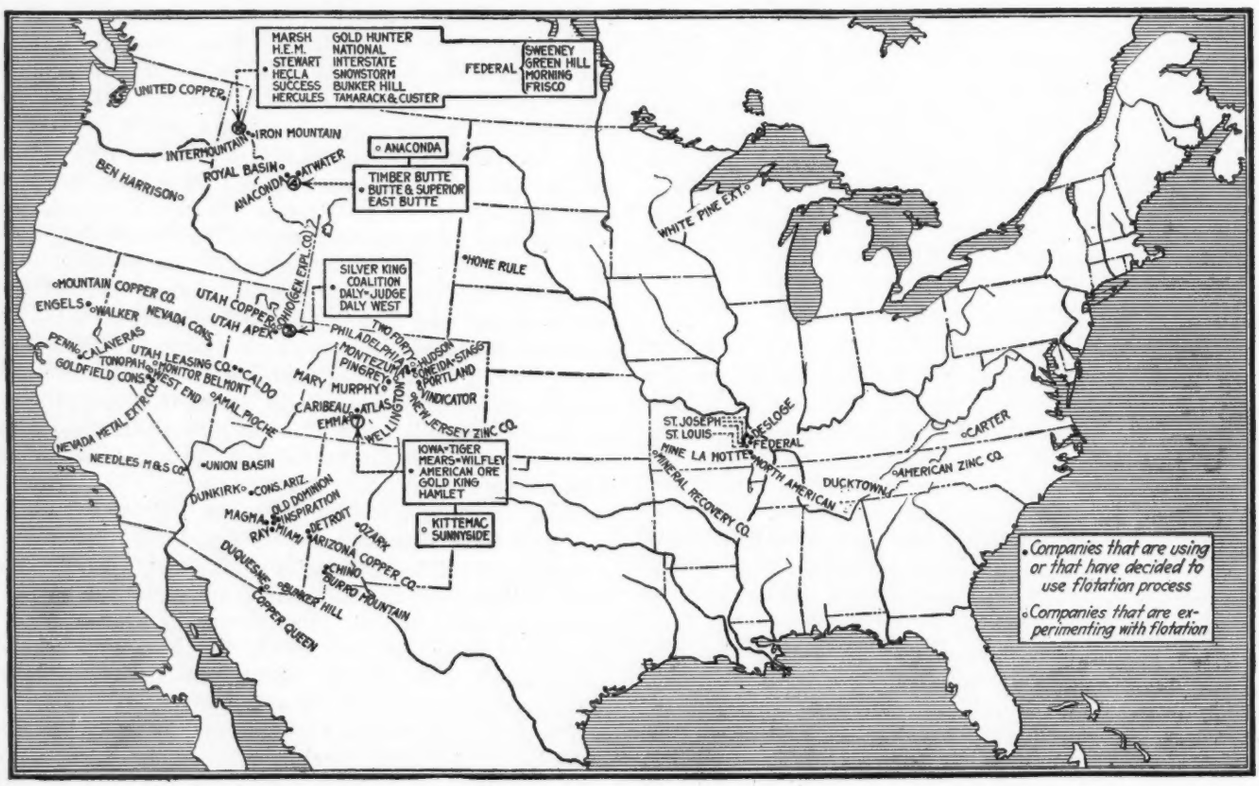
An important feature of the development of the year has been the indication that flotation is going to replace the cyanide process to a great extent. In those mines that produce silver principally in the form of sulphide, particularly when ores are of a rather low grade, it seems almost certain that a process of flotation concentration will be cheaper and more easily applied than the cyanide process. The liberation of sulphide particles for action by a flotation process makes fine grinding a necessity, but in fact all-sliming has been a standard process for so long that grinding problems have been essentially solved. The recovery of the sulphide from the pulp, then, is the stage in which flotation will probably be cheaper, quicker and easier than treatment by cyanide.

The treatment of silver sulphides by flotation is going to introduce another problem, however, and that is the handling of the concentrates themselves. Perhaps in the great majority of cases the high grade of the concentrates thus recovered will allow them to be shipped for considerable distances without running up the cost per ton of crude ore to an abnormal point. There will be cases, however, where it will be impossible to ship the concentrates, and their treatment will have to be attempted on the ground. Here cyanidation will probably be applied at the smaller plants, whereas in the plants big enough to make an output of any considerable tonnage and able to keep it up continuously, some form of smelting may possibly be introduced. The way is by no means clear as yet, but the problem is going to come up.

In the cyaniding of the concentrates obtained by flotation, it will be a problem to get rid of the oil contained in the sulphides. Filtration will not remove it all, and roasting the concentrates will bequeath an uncomfortable carbonaceous residue that will give trouble by precipitating the gold and silver from solutions. Perhaps some form of washing it out with an alcohol, which will remove the heavy oil and itself be removed by water, or by saponifying and washing out with some alkaline solution, will present a way out of the difficulty.

While the principal companies owning flotation patents are offering especially designed machines for its application, it is a notable fact that many of the operating plants have designed machines that seem to suit their particular conditions better. It is a remarkable fact that a very large proportion of the mills using flotation at all are using machines of their own design, sometimes in combination with those of the standard manufacturers and sometimes without them. The records of the Patent Office show a continuous stream of patents issued for flotation machines.

Successive cleaning of concentrates made by flotation is being practiced by nearly all the plants. The number of cleanings, however, varies immensely, some plants cleaning the concentrates but once, while others clean with as many as six different operations. The flotation concentrates, once formed, have to be cleaned in order



COMPANIES USING OR EXPERIMENTING WITH FLOTATION IN THE UNITED STATES

Owing to the large amount of experimentation now going on in this country with the flotation process, new companies are daily being added to this list or are changing their status from experimenters to users. While the map is therefore only of ephemeral value, it serves to indicate the great awakening that has taken place in the United States during the last two or three years with respect to flotation

to raise their grade, but in combination with the grade-raising process it has been found possible to select the particular sulphides to be floated and the ones to be left in suspension. By this means it seems possible to separate the different sulphides where an ore is complex and contains several different metals. Thus it is possible to make a large increase in the profits of the process, since many of the sulphide combinations are worth less than when they are sold separately. A well-known example is the combination of zinc and lead sulphides, which is undesired by the smelting plants and brings a considerably lower price than the lead and zinc when separated and sold with a view to the value of the one metal contained.

Effect of Varying Details

The effect of varying conditions upon flotation has been made the subject of considerable study, and some information has been made public. The effect of variations of dilution, the amount and kind of ore used, temperature at which the operation is carried on, etc., all appear to have some effect. As to dilution, it seems that when a constant specific gravity of pulp is maintained, it really does not make much difference what the exact figure is. The point is that the amount of oil used and the rate of flotation and skimming, etc., have been based on a certain dilution and that dilution must be maintained or the other factors will not be applicable. Undoubtedly, in some cases a thicker pulp may be maintained than in others, but in general it may be said that a pretty fair rate of dilution ought to exist in order to allow the free separation of the mineral grains from the gangue, giving the former a chance to float without any great amount of interference from the gangue particles.

The kind of oil used will probably depend largely upon the availability for local use of any particular oil. Of course it is true that some oils provide good froths, while others do not. Coal tars, for example, do not froth readily, but make good carrying agents for the minerals. Pine oils make common frothing agents. The cheaper coal tar, with a small proportion of the more expensive pine oil, will often make a good flotation combination. In Australia the eucalyptus oils are readily obtainable and have formed the frothing element in most of the oils used there. However, a great variety of oils may be used, among which may be mentioned pine oils, creosote, eucalyptus oils, pyroligneous, Texas crude, coal tar, oleic, stearic, and in fact all kinds of vegetable and mineral oils.

Applications of the Process

In the application of the process, the Australian fields have led the way and still continue to increase the applications. Most of the Australian mines have taken it up, the latest being the Wallaroo & Moonta, which has been making extensive experiments on the process. In the United States the process has been applied in almost every district, except in those where the mineral recovered is not of sufficient value to be handled by the process. The Goldfield Consolidated is trying out the process and has installed an experimental plant on rather a large scale. Goldfield will re-treat its large tailings pile and will probably make use of flotation in that connection. Some experiments have been made on the process at Tonopah, but as yet no definite conclusions, if reached, have been made public. In the Cœur d'Alene district, the process has worked practically a revolution in metallurgy, becoming an important addition to all the mills in operation there. In southeast Missouri it has been widely adopted, and the applications are spreading every day. In the Joplin district there is but one recorded application of the process. The Cripple Creek district has been trying it out during the year on the sulpho-telluride ores of the district, and many authorities believe it will lead to the rejuvenation of the district and an immense increase in the gold production of the old camp. Most of the Colorado mills have been trying it out, and with considerable success. The Arizona porphyry copper mills are using it, and in some of them an additional saving of 15% has been made. It is used also in mills of the Butte district of Montana. The Butte & Superior has long been a leader in flotation and continues to use the process successfully. The accompanying map will give a good idea of the applications of the flotation at the present time. It shows that there is hardly a metal-mining section of the country where flotation has not become a leading factor of interest and a subject of careful and detailed experimentation.

The year has certainly been a notable one for flotation, but it is also true that if publicity be given to the details of the process, the coming year will be even more remarkable. It is to be hoped that open discussion will be promoted and that the theoretical basis of the process will be more or less fixed.

The Theory of the Process

The theory of the process is one of the points that has been uncertain for some time, and while the year has brought forth several descriptions and tentatives bases for a theory, none of them has been sufficiently elaborated to prove its truth. The surface-tension theory, which accounts for the use of oil through the fact that it reduces the surface tension of the liquid and allows bubbles of a more permanent character to be formed, while explaining the phenomena partly, will by no means do as a complete explanation. In the article by J. M. Callow, which has already been mentioned here, a review of the theories of flotation is presented, together with some additional suggestions for a more stable working basis. The most important new idea advanced is that there is a parallelism between certain electrostatic characteristics and the flotation properties of ore. It has been noted that small amounts of some colloidal impurities interfere with flotation, and in classifying these the injurious ones will be found to come usually under the head of electronegative colloids, while electropositive colloids are not harmful. Thus the theory is advanced that electrostatic conditions have a great deal to do with the flotation of the mineral. There is very little doubt of the truth of this assertion, since it is possible to measure the difference in electric charge of the various kinds of particles in the pulp by means of a delicate galvanometer. The theory, however, is by no means clear, and a lot of work will have to be done to segregate the actual basic fact. The charges upon the solid particles in the pulp are in all probability ionic charges, and the reason for their presence and for their acting in the way they do will have to be clearly explained. There is no doubt that the application of a proper theory will be of immense assistance in forecasting the success or failure of flotation as applied to any particular ore or character of rock.

Gold Dredging in 1915

By Robert E. Cranston*

There was more activity in the dredging industry in 1915 than in 1914. More new dredges were built during the year, and at least as many old dredges were rebuilt. There was also a marked increase in the number of contracts let, and 1916 should show a greater number of new dredges put in commission than for several years past. The improvements in design follow the general tendencies of the last few years. All-manganese-steel buckets, round manganese-steel lower tumblers, steel hulls and increased table areas are all becoming standard practice, particularly in California, and there have been several special designs originated to take care of particular local conditions, such as the bypassing of clay overburden, resoiling, the use of jigs to replace tables and the grinding of jig concentrates in order to save a larger percentage of fine and coated gold. The improved financial condition of the country has had a good deal to do with the increased activity in the dredging business.

Alaska and the Yukon have at least held their own. Siberia is still in about the same condition as last year. At least two new dredges were built in Colombia, but I have heard of no other installations being made in South America, although several large areas are being tested on the west coast and in Central America. Perhaps the most active of any of the outside fields is the Philippines. There are six dredges now operating there and several more being built. The reports indicate that the profits are satisfactory. It is possible that there may be an extensive field developed in Chosen. A new dredge has recently been ordered for that field, and a number of areas look promising. The Breckenridge dredges continue to be productive, and Montana, Idaho, Oregon and Nevada have each one or more dredges operating successfully.

Dredging Conditions in California

In March the Oro Water, Light and Power Co. completed its 6-cu.ft. bucket dredge on the Mokelumne River near Clements, Calaveras County. Part of the machinery for this dredge was taken from the old Empire dredge at Oroville, and the new portion was built at the New York Machine Shop, at Oroville. It is rumored that this company contemplates extending its operations in Calaveras County, having made arrangements for additional mining rights on the Mokelumne River, near Comanche.

The old Horsetown dredge, which operated near Redding, has been moved to Gas Point, on Cottonwood Creek, Shasta County. Cottages, etc., have been built, and the new town is called Smith Center.

James Hawke has built a clamshell-type dry-land dredge on Deer Creek, 2 mi. west of Grass Valley. The gravel is dug by the clamshell bucket, screened, dropped into sluices and the oversize disposed of by means of a belt conveyor. The dredge is driven by steam, wood being used as fuel. The property extends about 2,300 ft. along the creek, and it is expected that 500 cu.yd. will be handled per day.

The New No. 4 Natomas dredge, now being rebuilt after a design that will make possible replacing the ground with soil on top, is perhaps the most interesting of any of the 1915 dredges. This boat has two short stackers, one at each corner of the stern. The fine material is carried aft a considerable distance beyond the point where the stackers dump and is discharged back of and above this coarse material. Jigs will replace the lower part of the gold-saving tables, and the concentrates from the jigs will be treated in a Hardinge mill. The operation of this dredge will be watched with a great deal of interest.

The Union Iron Works is building an all-steel 16-cu.ft. bucket dredge for the Marysville Dredging Co.'s property on the Yuba River. This will make the fifth dredge to be built on this property. It will be of standard California type and similar to the Yuba Consolidated's No. 14. The Yuba Construction Co. now has under construction for the Yuba Consolidated Co. an all-steel 16-cu.ft. dredge designed to dig 80 ft. below the water level, and it is said that this will be the most powerful and largest gold dredge that has yet been constructed. The Union Iron Works is rebuilding two 5-cu.ft. dredges for Lawrence Gardella. One of these will be installed near Lincoln, Calif., and the other will be put on the Salzer Ranch, 4 mi. south of Redding.

Besides the dredges that have been built or are building, there are several other California properties on which it is reported that dredges are being or will be built, but concerning which there is no definite knowledge. A list of these is given.

Yuba River and Marysville Conditions

The Mountain Meadows Dredging Co. expects to install a dredge near Greenwood, Plumas County. Another reported installation to be made in Plumas County is at English Bar, on the Middle Feather River. The Guggenheim Exploration Co. is reported to have contracted for a large dredge to operate on its recently acquired property on the Yuba River above the Yuba Consolidated ground. Clear Creek, east of Redding, has been tested by steam drills and it is reported that a dredge is to be installed. It is expected that the Valdor Gold Mining Co.'s property at Junction City, Trinity County, will be equipped with a medium- or small-sized dredge during the coming year, and Dr. James M. McIntire expects to install a small one at Bulls Bar, south of Copley, on the Sacramento River.

Considerable prospecting has been carried on in California during 1915, and among the areas tested may be mentioned the district in the vicinity of Carville and Trinity Center, on the Trinity River, and the Igo district, near Redding, Shasta County, both of these by the Tonopah Mining Co. The Marysville Dredging Co. tested the placers at Junction City, Trinity County, and the Guggenheim Exploration Co. has been examining the Yuba River above the Yuba Consolidated ground.

The only serious mishap reported during the year in California was the burning of the Viloro Syndicate dredge No. 2, at Oroville, on Oct. 19. The fire was caused by a short-circuit in the transformers, and the dredge is said to be a total loss. The United States Geological Sur-

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vey reports for 1914 show that 60 dredges produced $7,783,394, which is 86% of the total gold production of the state. The dredge production was $306,900 less than in 1913. The total dredge production from 1898 to 1914 inclusive has been $71,307,766. The figures for 1915 are not yet available.

The Feather River, Yuba River and American River districts still produce by far the greatest part of the gold won in California by dredging and there has been little apparent change in conditions. They are, however, inevitably approaching the time when there will be a marked decrease in production. The other smaller districts continue about the same as in 1914, with some decreases which, however, are made up by other small new areas being opened up.

Oregon, Colorado and Other States

The Powder River Dredging Co. has had a new dredge constructed during the year for its property near Sumpter, Baker County, Ore. This dredge was built by the Yuba Construction Co. and is a duplicate of its other boat. It is called Powder River No. 2, is electrically driven and is equipped with 7-cu.ft. buckets and designed for hard digging. Owners of the old Isabella dredge, which operated at Jenny Lind, Calif., are reported to be about to install a dredge in the Baker City district, Oregon.

On Oct. 9 a dredge went into commission on the Derry Ranch property, on the upper Arkansas River, in Colorado, below the mouth of the famous California Gulch of the Leadville district. The property has been thoroughly tested and 125 acres of land proven out of a total of 1,500 acres in the property. The New York Engineering Co. has rebuilt for this ground an old dredge using 5½-cu.ft. all-manganese-steel buckets, electric drive and wood hull, 107 ft. long and 42 ft. wide. The operating company is called the Derry Ranch Gold Dredging Co. The property of the Tin Cup Gold Dredging Co., of Colorado, was sold for $5,000 on Sept. 2, by the United States Court of Bankruptcy, and is now lying idle.

At Breckenridge, Colo., the Tonopah Placers Co.'s dredge No. 1 is operating below the town on the Blue River. No. 2 is operating well up the Swan River, and No. 3 is in lower French Gulch. The French Gulch Dredging Co.'s dredge operated on upper French Gulch. It is reported that a dredge is to be installed on the Oro Grande placer near Dillon, Summit County, Colo., and the old placers near Alma are being tested with a view of determining their value as dredging areas. In Idaho the American Placer Mining Co. installed a 3½-cu.ft. steam-driven dredge on the Orofino River 7 mi. below Pierce City. The company owns 100 acres of promising dredging land.

The Boston-Idaho Dredging Co., operating on the Feather River, near Featherville, Elmore County, Idaho, has worked only on a small scale this season, owing to lack of water. There are reported dredging activities in Montana, Nevada and Georgia, but the information available at this time is not reliable.

Alaska, the Philippines and Other Countries

The reports of new installations for Alaska are somewhat conflicting and, as I have noticed in the past, not always to be relied upon. However, I give a list, compiled from the technical press, which is probably fairly accurate although not complete. The new Berry dredge was moved from Circle City to Mastadon Creek during the early part of the year. This work was done under the direction of the Union Construction Co. The Kougarok Dredging Co. placed a dredge on Iron Creek, near Cordova, the machinery being freighted in over the winter trails. The Cache Creek Dredging Co. is preparing to freight in during the coming winter a new 7-cu.ft. dredge, which is to operate in the Yentna district back of Cooks Inlet. This will be the first dredge in this district. The Yukon Gold Co., of Dawson, has bought 3½ mi. of placer ground on Greenstone Creek in the Ruby Camp, and it is reported that it will install a 3½-cu.ft. steam-driven dredge in the near future.

Two dredges were built by the American Dredge Building and Construction Co., of Seattle. One on Six Mile Creek, near Sunrise, southwestern Alaska, for Barnes & Herron, was designed to dig 20 ft. below water level. The other dredge was built and installed on Buck Creek, near York, Alaska, for the American Tin Dredging Co. It is designed to dig 12 ft. below water and to recover gold and tin. Both dredges have 2-cu.ft. buckets and 80-hp. gasoline engines.

The Alaska Exploration Co., which has been operating a 3½-cu.ft. dredge on Fairbanks Creek for several years, is considering the installation of a large steam shovel to operate some newly acquired property on a tributary of the upper Goldstream. It is reported that the Anaconda group of placers near Fairbanks will install a dredge next year. A. J. Jarmouth and associates, of New York, will install a 5-cu.ft. Bucyrus dredge on Cripple Creek, 12 mi. from Nome. The machinery is being shipped north this fall and will be installed in the spring.

Prospecting in Alaska

There has been much prospecting going on in Alaska and the Yukon during the summer. Among other properties examined were the Timmons, in the Tatlanika district, out from Fairbanks, the Kenai River country, Valdez Creek, the new Talovana district, the Yakataga Beach placers and many more. There were 42 dredges reported operating on the Seward Peninsula. Many of these, however, were very small affairs, and the production was light.

No. 2 Canadian-Klondyke dredge, which overturned in the autumn of 1914, was righted and dry-docked on July 20, but owing to an accident on July 23 in which one man was killed and 3 injured, the dredge could not go into commission as soon as expected. It was restarted on Sept. 21, and the cleanup will be about 65,000 oz. The other three dredges of this company started work early in the season and probably got in a good season's work. Serious accidents to Riley & Marston's dredge, operating on Alter Creek in the Iditarod district, compelled this dredge to close down much earlier than was expected, but the Bagley scraper excavating the dry portion of this placer along the stream is reported to have been successfully used during the season.

Most of the dredging in the Philippines has been in the Paracale district, Province of Ambos Camarines, Island of Luzon. Early in 1913 four dredges were operating in this field. In April, 1915, six dredges were at work and four more ordered or being constructed. Three of these are being built by Philippine Dredging, Ltd. One has 8½-cu.ft. buckets and a wooden hull, one has 6-cu.ft. buckets, and the third has 9-cu.ft. buckets, is all

steel and is being built in Australia. The other dredge under construction is being built by the New York Engineering Co. for the Mambulao Placer Co. This dredge will operate in salt water in the bay of Mambulao, Island of Luzon, and has several unique features. The hull has more the lines of a ship than an ordinary dredge. It has a clay chute to bypass the barren overburden. The machinery is electrically driven by means of current generated on the dredge by a steam turbo-generator set. The dredge is designed to dig 55 ft. below water line. The hull is 136x47x10 ft. and is built of wood protected by ship-sheathing felt to prevent boring by insects. The buckets are of one-piece manganese steel, the lips being cast integral with the hood and base.

Besides the new installations in the Paracale district, new placer machinery is being installed in the districts of Tayabas, Rizal and Surigao. The reported production of gold in the Philippines for 1914 was $1,203,433. Nearly one-half of this came from dredges, and the 39% gain in production over 1913 was mainly due to this source.

In South America two new dredges were built, one of which was for the Nechi Mines (Colombia), Ltd., near Zaragoza. This property is controlled by the Oroville Dredging Co., Ltd., and is to be operated in conjunction with the Pato dredge. The Nechi dredge was ordered in England from Fraser & Chalmers. It has 7½-cu.ft. close-connected buckets. The hull arrived in Colombia in November, 1914, and the dredge was put in commission in September, 1915. The Anglo-Colombian Development Co. started its 8-cu.ft. dredge on July 20, in the Condoto River, in western Colombia.

In November, 1915, the Chiksan Mining Co. placed an order with the New York Engineering Co. for a 10½-cu.ft. dredge for its property in Chosen. This dredge will be designed with large factors of safety and will be of the most uptodate California type. It will be provided with a bypass for taking care of the clay and resoiling the ground dredged. The hull will be of steel, 110x50x10 ft., and the dredge is designed to dig 25 ft. below water line and to carry a 15-ft. bank.

Economic Geology in 1915

By Adolph Knopf*

The origin of the zinc and lead deposits of the Joplin region, which includes parts of Missouri, Kansas and Oklahoma, is exhaustively considered by C. E. Siebenthal (U. S. Geol. Surv., Bull. 606). His theory, in brief, is that the ore deposits were segregated from zinc and lead sulphides originally disseminated in the Cambrian and Ordovician strata, from which they were dissolved by alkaline-saline waters and deposited on the upward limb of an artesian circulation. The orebodies occur in a belt lying on the flank of the structural dome known as the Ozark uplift. As a consequence of this uplift the stratified rocks were warped into the shape of a low, broad dome whose flanks dip away from the center at the rate of 6.6 ft. to the mile.

After the impervious rocks had been removed by erosion from the crest of the dome, an artesian circulation was developed in the lower-lying pervious rocks. The underground waters flowed down the sides of this dome in the Cambrian, Ordovician and overlying rocks; and as they were charged with salts of the alkali metals, with hydrogen sulphide and with carbon dioxide, they were able to extract the zinc and lead from the strata through which they moved. As these waters rose to the surface along the channels of ascent of the artesian circulation, which were situated along the inner edge of the overlying impervious shale formation encircling the dome, the carbon dioxide escaped and the dissolved zinc and lead were precipitated as sulphides by the hydrogen sulphide.

Action of Cold Artesian Waters

The ore-forming waters are thought to have been similiar to waters now rising under similar conditions in the surrounding region. The most important evidence in support of this is that the sediments that accumulate in reservoirs supplied by wells penetrating the Ordovician and Cambrian rocks contain considerable quantities of zinc, lead and iron sulphides, so that it is clear that the waters of the Ozark artesian circulation are now dissolving the metals dispersed through the Cambrian and Ordovician strata and are bringing them to the surface.

Without summarizing the large amount of evidence that Siebenthal has marshaled in support of his contentions, it can be said that he has practically demonstrated that cold artesian waters have deposited orebodies of great commercial importance, Joplin being the most productive zinc district in the United States. According to current thought, most orebodies have been deposited from hot solutions given off by cooling igneous rocks (and there have not been wanting those who have suggested such an origin for the Joplin deposits, though no one who has studied them in detail has supported such an explanation, and in view of the prevailing trend of thought concerning the genesis of ore deposits, this demonstration of the efficacy of cold meteoric water as an ore-forming agency consequently gives to the report an additional significance.

The opposite pole of geologic thought is seen in a paper by B. S. Butler, on the relation of the ore deposits of Utah to different types of intrusive bodies of igneous rocks ("Econ. Geol." pp. 101-122). The ore deposits of Utah are generally associated with igneous rocks, and the author assumes as not requiring proof that the orebodies and igneous rocks are genetically related in the sense that both have sprung from the same magmas. The value of the metalliferous output to the close of 1913 exceeds $635,000,000. Of this sum less than ½% has come from ore deposits associated with laccoliths or with "medially truncated" stocks; and of the $111,000,000 dividends known to have been distributed by metal-mining companies, all has come from deposits occurring in or near "apically truncated" stocks; in other words, with igneous intrusions whose tops have been but slightly uncovered by erosion.

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The explanation advanced for the remarkable relations thus strikingly pointed out is that the magmatic emanations, which are the ore-forming agencies, tend to collect in the tops of the stocks, and when the igneous rock has cooled sufficiently to fracture, to escape through these channels and deposit their metallic burden; in the "medially truncated" stocks and more deeply uncovered igneous masses, erosion has progressed deep enough to have removed the roots of the veins. If this explanation is correct, the actual disappearance of veins in depth ought to be observable in some of the stocks. This is thought to be true of the Cactus lode in the San Francisco stock. At the surface the lode is a mineralized breccia zone over 100 ft. wide and traceable along the strike for several thousand feet. In depth the breccia zone tapers rapidly, so that at 900 ft., it is only a few feet wide and the brecciation is much diminished. As might be expected of such orebody, the tap root of a great lode, the earliest formed minerals occurring in it are of the kind that prove it to have been formed at high temperature.

The extensive deposit at Meggen, Westphalia, consisting of barite and iron sulphide, is thought by A. Bergeat ("Neues Jahrb. Beil. Band" 39, pp. 1-63) to be a stratum formed in the Devonian sea. The iron sulphide is chiefly marcasite in radial, rhythmically banded spherules, which show shrinkage cracking from the decrease in volume during the passage from the colloidal to the crystalline state; and the barite, forming the largest known deposit of this substance, generally lies above the sulphide, the two together forming a bed ranging in thickness from 5 to 20 ft. The deposit is commonly explained as a metasomatic replacement of limestone, followed by replacement of the barite by pyrite. Bergeat, however, regards it as of sedimentary origin, although its deposition in the Devonian sea was ultimately conditioned by the volcanic activity of that time.

Work on Gold and Platinum

The most remarkable of high-grade gold ore yet found in the West, that at National, Nev., is described by W. Lindgren (U. S. Geol. Surv., Bull. 601). This shoot produced nearly $4,000,000 in ore averaging $20 per lb. Only one-sixtieth part of the quartz in the shoot was rich ore. The shoot is an abnormal phase of the argentiferous quartz-stibnite veins of the district, none of which, however, has attained notable commercial importance. It is shown to be of primary origin; since its original deposition there has been no redistribution of gold or silver by the action of descending surface waters. Beyond this, however, the explanation of the extreme localization of gold in this shoot remains an enigma.

Platinum and palladium have recently been recognized in the gold ore of the Boss mine, in southern Nevada (U. S. Geol. Surv. Bull. 620-A). The deposit has been known for 30 years; attempts had been made to work it for copper in the '90s, but only in 1914, while being sampled for gold, was its platinum and palladium content discovered. The ore is a fine-grained gray to black quartz, and is not only peculiarly worthless looking, but is also material which it would have been considered wholly improbable to contain platinum or palladium. The precious metals are especially associated with a greenish-yellow ocher, locally known as talc, which carries gold, platinum and palladium to the extent of several hundred ounces to the ton. The ocher, when immersed in highly refractive oils and examined under the microscope, is found to consist largely of plumbojarosite, a basic sulphate of lead and iron, and subordinately of beaverite, a basic sulphate of copper, lead and iron. Both minerals are crystallized in perfect hexagonal plates averaging less than one-thousandth of an inch in diameter. It is to this crystalline development that they owe their smooth talc-like quality. The lode is a replacement of Carboniferous dolomite along a series of vertical fractures and is probably related genetically to the quartz monzonite porphyry intrusions that penetrate the rocks of the region. The geologic features of the deposit run counter to a number of long-cherished generalizations concerning the geology of platinum. Production of platinum and palladium began late in 1914, and a yield of 110 oz. of platinum and 168 oz. of palladium was reported, the largest production of these metals as yet from a lode mine.

Developments in the Geology of Iron

The iron-ore deposit of Kirunavaara in northern Sweden is the largest body of high-grade iron ore now being worked anywhere. It is 10,000 ft. long, averages 250 ft. in thickness and carries 66% metallic iron. Those who have studied this deposit in recent years agree that it is of igneous origin. As to the kind of igneous mass it represents, however, opinions are still at variance, some holding that it is a dike and others, a great outflow of lava which was covered soon after its eruption by the quartz-porphyry that now forms the hanging wall of the orebody.

In a recent paper, Daly ("Origin of the Iron Ores at Kiruna," p. 31) advances a new explanation. He believes that the syenite-porphyry, which forms the foot wall of the orebody, and the hanging-wall quartz-porphyry together make up a double or composite laccolith. The quartz-porphyry magma was injected shortly after the consolidation of the underlying syenite-porphyry. After it came into place, magnetite began to segregate from the still molten rock, collecting into irregular nodules. Under the pull of gravity these heavy nodules of magnetite sank to the bottom of the quartz-porphyry mass, there to coalesce and form the great mass of iron ore now being worked. In the late stages of this process many of the magnetite nodules were frozen in at higher levels of the porphyry and now afford clues to the mechanism by which the orebody originated. That the foot-wall syenite-porphyry was still hot when the quartz-porphyry was injected, thus retarding the rate of cooling of the younger intrusion, was probably an important factor favoring the voluminous separation of iron ore.

Coal and Oil Resources

"Coal Fields and Coal Resources of Canada" (Geol. Surv. Canada, Mem. 59) by D. B. Dowling is a reprint, with some additions, from "The Coal Resources of the World," a volume prepared under the auspices of the Twelfth International Geological Congress, and gives in more available form the data on Canada.

Certain important relations in origin between coal and petroleum are pointed out by David White ("Wash. Acad. Sci. Journ.," Vol. 5, pp. 189-212). As shown by a consideration of the data of the world's oil fields, the petro-

leums exhibit regional differences that vary correspondingly with the rank of the coals in the same fields. In general, the oils of lowest rank occur in the regions and formations in which the carbonaceous deposits are least altered. In proportion to the amount of dynamic disturbance to which a region has been subjected, the hydrogen is concentrated in the distillates and the carbon in the residual coals or carbonaceous shales. No commercial oil pool has ever been found in regions in which the elimination of the gaseous constituents of the coal has proceeded beyond 70% of fixed carbon. This relation appears, therefore, to furnish a criterion of broad applicability in the search for oil; it shows at once that large areas of sedimentary strata can be excluded as territory in which it would be futile to prospect for oil and directs attention to areas in which search may be more profitably prosecuted.

Anderson and Pack describe the oil-bearing strata and associated formations of the west border of the San Joaquin Valley north of Coalinga, Calif. (U. S. Geol. Surv., Bull. 603, p. 220). The oil is shown, by what practically amounts to proof, to have originated from two distinct shale formations widely separated in age, the older being Cretaceous and the younger Oligocene. These shales are largely composed of the siliceous remains of microscopic aquatic plants—diatoms—which are mingled with a certain proportion of the remains of the microscopic animals termed *foraminifera*. The older shales gave rise to a paraffin-bearing oil, and the younger shales to an asphaltic oil. The sources of the oil being known and the structural relations of the various formations having been determined, the practical questions that arise concerning the extension of the oil-bearing territory can be discussed with considerable certainty.

Selenium

The year's demand for selenium has been much curtailed through absence of buying orders from the railroad for signal lamps and no possibility of shipments to Germany and Austria, although some metal was shipped from Baltimore to Rotterdam. The copper refineries have decreased production and even offer direct to consumers in small parcels. The price has ranged from $2 to $5 per lb.

Both the United States Metals Refining Co. and the Raritan Copper Works had interesting exhibits at the Chemical Exposition in New York, the Raritan bars being especially noteworthy for the large masses cast in vitreous form. Methods of production have been changed by some of the leading producers, the slags from the slimes furnaces being used rather than the flue dusts. It is impossible to estimate the production.

Molybdenum

In the early part of 1915 the inquiry for molybdenum products dropped to practically nothing, the sudden demand in the last quarter of 1914 proving to be but a temporary interest. That demand, however, caused molybdenum to be prospected for as never before, with the natural result that molybdenum ores are offered very freely, with practically no demand at the present time.

The Primos Chemical Co. shut down its Empire operations in Colorado on Sept. 1, as it had such a large stock of molybdenum ores at its works in Pennsylvania that it figured it would take a long time to absorb at the present rate of consumption. Efforts made to broaden the use of molybdenum at least to what it was from 1900 to 1905 have thus far failed, and what the future will bring depends a good deal on experiments still going on.

At the present time there is no demand for molybdenum ores amounting to any tonnage, and low-grade ores such as were bought in 1914 are not taken now, there being so large a supply of very high-grade ores in the market.

State Geological and Mining Officials

The following lists of the directors of state geological surveys and of the chiefs of state mine-inspection bureaus, constitute a convenient reference:

STATE MINE INSPECTORS, COMMISSIONERS, ETC.

State	Name and Address
Alabama	C. H. Nesbit, Chief Mine Inspector, Birmingham.
Alaska	Sumner S. Smith, Mine Inspector, Juneau.
Arizona	C. H. Bolin, State Mine Inspector, Phoenix.
	Charles F. Willis, Director, State Bureau of Mines.
Arkansas	John H. Page, Commissioner, Bureau of Mines, Manufactures and Agriculture, Little Rock; John T. Fuller, State Mineralogist; Tom Shaw, State Mine Inspector, Midland.
California	F. McN. Hamilton, State Mineralogist, San Francisco.
Colorado	Fred Carroll, Commissioner.
	James Dalrymple, State Inspector of Coal Mines, Denver.
Idaho	R. N. Bell, State Mine Inspector, Boise.
Indiana	Michael Scollard, Deputy Inspector of Mines, Indianapolis.
Iowa	E. M. Gray, Pres., State Mining Board, Des Moines.
Kansas	John Pellegrino, Chief Mine Inspector, Pittsburg.
Kentucky	C. J. Norwood, Chief Inspector of Mines, Lexington.
Maryland	William Walters, State Mine Inspector, Midland.
Minnesota	F. A. Wildes, State Mine Inspector, Hibbing.
Missouri	George Bartholomaeus, Sect., Bureau of Mines and Mines Inspection, Jefferson City.
	George Hill, Chief Mine Inspector, Bevier.
Montana	W. B. Orem, State Mine Inspector, Helena.
Nevada	A. J. Stinson, State Mine Inspector, Carson City.
New Mexico	Rees H. Beddow, State Mine Inspector, Gallup.
New York	W. W. Jones, State Mine Inspector, Albany.
North Dakota	James W. Bliss, State Engineer, Bismarck.
Ohio	J. M. Roan, Chief Deputy, Division of Mines, Columbus.
Oklahoma	Ed. Boyle, Chief Inspector, McAlester.
Oregon	H. M. Parks, Director, Bureau of Mines, Corvallis.
Pennsylvania	James Roderick, Chief, Department of Mines, Harrisburg.
South Dakota	Otto E. Ellerman, State Mine Inspector, Lead.
Tennessee	R. A. Shiflett, Chief Mine Inspector, Nashville.
Texas	I. J. Broman, State Mine Inspector, Austin.
Utah	J. E. Pettit, State Mine Inspector, Salt Lake City.
Virginia	Capt. Richard B. Roane, Mine Inspector, Richmond.
Washington	James Bagley, State Inspector of Coal Mines, Seattle.
West Virginia	Earl Henry, Chief, Department of Mines, Charleston.

STATE GEOLOGISTS

Alabama	Eugene A. Smith, University.
Arkansas	N. F. Drake, Fayetteville.
Connecticut	William N. Rice, Supt., State Geol. and Nat. History Survey, Hartford.
Colorado	R. D. George, Director, Boulder.
Florida	E. H. Sellards, Tallahassee.
Georgia	S. W. McCallie, Atlanta.
Illinois	F. W. DeWolf, Director, Urbana.
Indiana	Edward Barrett, Indianapolis.
Iowa	George F. Kay, Des Moines.
Kansas	W. H. Twenhofel, Lawrence.
Kentucky	J. B. Hoeing, Frankfort.
Maryland	William Bullock Clark, Baltimore.
Michigan	R. C. Allen, Lansing.
Minnesota	W. H. Emmons, Minneapolis.
Mississippi	E. N. Lowe, Jackson.
Missouri	H. A. Buehler, Rolla.
Nebraska	E. H. Barbour, Lincoln.
New Jersey	H. B. Kümmel, Trenton.
New York	John M. Clarke, Albany.
N. Carolina	Joseph Hyde Pratt, Chapel Hill.
N. Dakota	A. G. Leonard, Fargo.
Ohio	J. A. Bownocker, Columbus.
Oklahoma	C. W. Shannon, Norman.
Pennsylvania	R. R. Hice, Beaver.
Rhode Island	Charles W. Brown, Providence.
S. Dakota	Freeman Ward, Vermillion.
Tennessee	A. H. Purdue, Nashville.
Texas	J. A. Udden, Director, Bureau of Economic Geology, Austin.
Vermont	G. H. Perkins, Burlington.
Virginia	Thomas L. Watson, Charlottesville.
Washington	Henry Landes, Seattle.
West Virginia	I. C. White, Morgantown.
Wisconsin	W. O. Hotchkiss, Madison.
Wyoming	L. W. Trumbull, Cheyenne.

These lists were compiled in December, 1915, from the latest information available at that time.

It will be seen that of the 48 states of the Union, 34 have organized geological surveys.

General Review of Mining in the United States in 1915

By P. E. Barbour

All estimates of mineral production in the United States for 1915 indicate that it has been the most prosperous year in the history of mining. The gross output will probably be found in excess of $2,000,000,000. The year has been marked by record productions in both copper and zinc and, owing to the war, in the semi-rare metals also, such especially as tungsten. Iron mining did not reach the total of the 1913 activities, but fell short of the production of that year only.

The industry has been subjected to prolific and not altogether wise legislation and to a considerable amount of labor unrest, based largely on the miners' conception of an unfair distribution of profits; has witnessed a noteworthy boom in Arizona gold mining; has seen developed from obscurity the country's third largest zinc producer; a wild country-wide scrabble for tungsten ores; one terrible accident; the blowing-in of two new large copper smelteries, and has seen the entire mining world go "flotation mad."

Arizona

Except in the southern part of the state, labor conditions were eminently satisfactory throughout Arizona during 1915. There was an ample supply of labor, and wages have been almost universally increased by the general adoption of a sliding scale, depending upon the market price of copper. In the southern counties, where Mexican miners are used to a large extent, there has been an over-supply of men, owing to the entire breakdown of the mining industry in Mexico on account of the continued revolutions.

In the Clifton-Morenci-Metcalfe district a strike was called on Sept. 11, based on a demand for increased wages and recognition of the union, which has completely tied up that section to date. Although the struggle has been comparatively free from violence, thanks in a large measure probably to the prohibition law of the state, the contest has been desperate and acrimonious and no solution of the difficulty is in sight. Militia has been sent to the district, and its use and the Governor's action generally have been criticized, and a petition has been circulated for the recall of the Governor. On account of threats, both by the strike leaders and the Governor, the mine managers left camp and established headquarters in El Paso, where they still remain.

High prices for both base and semi-rare metals have greatly stimulated production. This condition has tended to stimulate mining and to make for the opening up of a large number of new properties and the reopening of many old properties that have been closed down over a period of years. The smelting companies conducting a custom business have been keenly affected by this situation and have been obliged to increase their smelting facilities in order to handle the products of outside mines and concentrators, which are offered freely. All of the smelting companies are crowded to capacity.

The Helvetia property near Tucson opened a small high-grade molybdenite deposit and shipped in excess of $30,000. In the Dragoons the Primos Chemical Co. has reopened its tungsten mines, and in northwestern Arizona there has been considerable activity in the search for tungsten and molybdenum..

There has been little change in the transportation facilities in the state during the year, except in so far as the good-roads movement has had results. Several counties have voted large bond issues for good roads, and motor-truck haulage is becoming more and more common. The Calumet & Arizona Mining Co. started construction of a railroad to connect its copper mines at Ajo with the main line of the Southern Pacific at Gila Bend, and it is reported that the Santa Fe is contemplating building a spur into the Oatman camp.

A most drastic prohibition law went into effect in Arizona on Jan. 1, 1915, under which no alcoholic liquors may be shipped into the state even for home or personal use, nor can pure alcohol be obtained within the state for any purpose whatsoever. A general beneficial effect of this law is recognized even by those who are opposed to such drastic measures. This has undoubtedly been a factor in preserving order in the Clifton strike situation, and is also responsible for the cleanliness and orderliness of the boom camp at Oatman, where also, on account of the lack of booze, the red-light district has not thrived as is generally the case in a boom mining town. With this single redeeming feature, the Arizona Legislature, inspired apparently by labor men, passed some pernicious legislation which has hampered and restricted the mining industry in many ways. The 80% law, restricting the number of alien citizens employed in a mine to one in every five of the total number employed, was declared unconstitutional by the Supreme Court. The anti-blacklist law acted as more or less of a boomerang to the trade unionists, as the larger companies simply moved their hiring organization into California or Texas, and with the exception of this inconvenience, the situation was not changed. It is expected that this law also will be killed by the higher court. The miners' lien law—a misnomer, as the law really provides for liens for everybody—which the legislature attempted to improve, is now in an indeterminate condition until the State Supreme Court has passed on it.

The sale of the Bush & Baxter property near Twin Buttes, about 50 mi. northwest of Nogales, was of considerable importance. The deal involved $100,000. Copper-sulphide ores are now being shipped on a considerable scale under the management of the Guggenheim interests.

The mines of the Tombstone Consolidated, at Tombstone, were acquired by Phelps-Dodge and are now being operated under the title of the Bunker Hill Mining Co. In the Tom Reed-Gold Road district there have been many sales and transfers of property, some of considerable magnitude, and to interests of national importance. The majority, however, were on terms and depend to a considerable extent on future developments, which are being rushed in all cases. Owing to the war, labor difficulties, adverse legislation, etc., Arizona has not at-

tracted the outside capital for new mining enterprises (excepting of course the Oatman boom) which it otherwise would have done under the stimulus of high metal prices and new finds of ore.

Of course the most striking development in Arizona during the year was the Oatman boom,[1] in which the United Eastern was the star performer. On the 465 level a large body of ore was encountered which has developed into one of the most promising gold mines in the country. This inspired a boom, and nearly 100 companies, with a capitalization of nearly $100,000,000, have been formed to operate in this section of Mohave County.

Zinc ore is also being mined in this section, as are several of the semi-rare metals, stimulated of course by the unusually high prices.

The development of the United Verde Extension mine at Jerome has produced remarkable results. The ore was struck in April, and shipping to the Clarkdale smeltery began in May. Shipments to Dec. 1 had amounted to $650,000; most of the ore shipped having come from development work and having averaged about 45% copper.

Inspiration started up its first 7,000-ton section of its new flotation plant, and work on a second section is nearly completed. Flotation plants have been installed, and operations started at widely scattered points in Arizona. The Hayden Development Co. erected and put in operation a 125-ton cyanide plant to treat the ores of the Copper Chief Mining Co., whose mines are situated 5 mi. south of Jerome. The Big Pine Consolidated, near Prescott, expected to install a 100-ton cyanide plant, but for various reasons had to postpone the beginning of construction until next spring.

The Miami made changes in its mill, increasing the capacity from 3,000 to 4,200 tons daily, and the Ray Consolidated during the first three-quarters of the year produced nearly 44,000,000 lb. of copper, or at the rate of about 5,000,000 lb. per month.

Two new smelteries were started during the year—the International at Miami, and the United Verde at Clarkdale. The Consolidated Arizona, at Humboldt, increased its capacity by adding another reverberatory furnace, and changes increasing capacity were made at the Douglas plants.

Colorado

There has been no change in the labor or transportation situations in the state during the year, the latter remaining generally unsatisfactory to the shippers. Considerable work has been done in various parts of the state, improving wagon roads, which encourages the use of motor trucks for local ore haulages.

There have been no changes in the lead-smelting ore markets, and shipments to the smelteries have not declined as compared with previous annual tonnages, which is remarkable when the low price of silver during the year is taken into consideration. There has been a brisk demand for Leadville carbonates on ores containing as low as 20% zinc, and all known deposits are being worked to the fullest extent. A great variety of schedules exist covering the purchase of these ores, which, with the varying grades of ores, results in a great many market vagaries. In addition to carbonates carrying over 20% zinc, there are in the Leadville district large quantities of lower-grade ore which find a limited market at the local plant of the Western Zinc Oxide Co., which has been operating throughout the year.

Manganese ores being again in demand, a market has been created for the manganiferous iron oxides which, being too low in silver to ship to lead-smelting works, are now profitably disposed of to the steel works.

The Wanakah smeltery, at Ouray, has operated intermittently during the year, chiefly on Wanakah ores, and has furnished a more or less attractive market for local producers, without diverting any considerable tonnage from other channels.

The Workingmen's Compensation Act is generally satisfactory to the operators, although it largely raised the rate of liability insurance. The mines were appreciably benefited by the restoration of the old law, taxing mines on one-quarter only of the gross output, until the net exceeds one-quarter of the gross, after which that becomes the basis for taxation.

A great many sales of mining properties have taken place during the year. Some of the more interesting are the sale of the Humboldt mine to the Smuggler-Union Co.; purchase from the Revenue Tunnel company of the northerly extension of the Montana vein by the Tomboy company; the largely increased holdings of the Primos Chemical Co., and the acquisitions by the Freeland Development and Tunnel Co. The most important sales of the year, however, were probably the purchase of the Golden Cycle by the Vindicator, in the Cripple Creek district, for $1,250,000 and the purchase of Strattons Independence by the Portland for £65,000 (approximately $300,000).

The most sensational discovery in gold mines in the state during the year was the opening of the now famous vug in the Cresson mine, in Cripple Creek; one shipment from which having netted $468,637.29.

Owing to the high price of tungsten, there was a scramble among prospectors for tungsten property, and several discoveries have been reported over a widely scattered area. The activity of course eventually centers around the Primos Chemical, the Boulder Tungsten Production and the Nederland Tungsten Production Co.'s activities. The treatment of tungsten ores at the Yukon mill is the second attempt at concentration of this material in the San Juan district; Wetherill magnetic separator and Plumb jigs are being used in these experiments.

The state is going mad over flotation, the process is heralded as a cure-all for many ores that have not been profitable under other treatment and numerous premature flotation installations are being made.

In the Leadville district the larger operating companies have maintained their regular output except the Western Mining Co., which, operating through the Wolftone shaft, was probably the largest producer of zinc-carbonate ore in the country, has, owing to the depletion of ore reserves, reduced shipments to about 6,000 tons per month.

The most important enterprise undertaken in the Leadville district during 1915 is the unwatering and rehabilitation of the so-called "Down Town" area, which embraces that portion of the district covered by the city itself. For many years previous to 1907 mines located in this area were profitably operated on the ores in the deep-lying formations under the city; this mining was

[1]Described at length in "Eng. and Min. Journ.," Jan. 1, 1916.

discontinued during the panic of that year and the workings were allowed to flood with water. During the last two years leases covering the whole area have been obtained, and the Down Town Mining Co. was organized to unwater and continue the working of the ground. Progress to date has been satisfactory, and the water has been lowered to within 180 ft. of the bottom of the shaft.

The American Smelting and Refining Co. spent $250,000 in improvements at the Arkansas Valley smeltery during 1915. These improvements consist largely of the installation of roasting equipment to take care of the increasing tonnage of sulphide ore resulting from the deeper development of the Leadville mines.

The leasing system has been so extended in Cripple Creek district that, together with the larger developments previously mentioned, the district has had one of its most profitable years. Of great importance to its future is the resumption of work in the Roosevelt Drainage Tunnel, which will be extended about 2 mi., making a total length of 5 mi., at an estimated cost of $200,000, which work is expected to require about two years. This will drain the Vindicator, Golden Cycle and other mines situated beyond a nearly vertical syenite dike, which, being impervious, prevents these mines benefiting from the drainage now afforded mines on the other side of the dike. The tunnel is at present flowing 13,000 gal. of water per min.

California

There have been no important changes in either the labor situation or the ore market in California during the year 1915. There has been considerable legislation, much of which, including the semimonthly payday bill and the workingmen's compensation law, is considered of very doubtful value by the mining companies.

The Dutch-Sweeney-App mines, in Tuolumne County, were acquired by the Bewick, Moreing & Co. interests who, with American money, have undertaken an extensive mining campaign.

Hydraulic operations in Nevada and Placer Counties were stimulated by efforts on the part of mine owners in various districts to secure congressional appropriation amounting to $150,000, for building a retaining dam on Bear River.

There was apex litigation in Grass Valley between the Empire and the Golden Centre, the North Star and the Empire Mine and Investment Co., and the Kennedy Extension and the Argonaut.

The smoke farmer was busy again in California throughout the year, and did more or less to harass the various smelting companies, though not sufficient to affect their operations. Against the Penn Mining Co. 35 suits were filed at Campo Seco during the early part of the year. The total amounted to $334,314. The Mammoth Copper Co. was again purged of contempt by the United States District Court denying the petition of the Shasta County farmers filed the year previous. Later in the year the smelter-fume question in the Redding-Kennett district was revived by the farmers, and an investigation was started by the State Veterinarian, who was also a member of the State Smeltery Waste Commission. The pernicious activities of the smoke farmers have prevented the starting up of the Balakalala smeltery, but in order to avail itself to some degree of the benefits of high copper prices a contract has been entered into with the Mammoth, whereby the latter company will smelt the Balakalala ores, and regular shipments are being made. Lassen Peak indulged in another series of eruptions during the summer months, and while these were spectacular, they did no special damage.

Motor trucks for ore haulage are becoming increasingly common. By their use the Ubehebe District, in the northeastern part of Inyo County, hopes to find an outlet for its ores, which will aid in developing and exploiting this isolated district, now showing considerable activity.

Prospecting for, and mining of, tungsten ores received the greatest impetus. Every available piece of ground within miles of Atolia has been located, and many leasers are taking out tungsten ore and making better than wages. The Atolia Mining Co., around which all of the tungsten activity centers, because of its milling facilities, has installed a new plant for concentrating scheelite.

Operations in Modoc County during 1915 have been on moderate scale, but in Eldorado County there has been a pronounced mining revival.

In Inyo County the Wilshire Bishop Creek mine has proved up a larger extent of ore than was anticipated, and the Cerro Gordo has, besides extremely encouraging underground work, built an aërial tramway 29,118 ft. long, to transport ore from the mine to Keeler, the shipping point.

Placer mining for gold, for years considered a decadent industry in California, has for the past 18 yr. been growing in importance, until now the placer mines are producing 44% of the total gold yield, the other 56% coming from deep mines, according to the United States Geological Survey. This condition has been entirely brought about by the dredging operations, the gold dredges now producing 86% of the placer gold. During 1915 there were 67 gold dredges in California, of which 6 were closed down all or part of the time and one was burned, leaving 60 active. A 16-cu.ft. bucket dredge is under construction for the Yuba Consolidated, in Yuba County, and another one of equal capacity (to dig 70 ft. below water line) is being built for the Marysville Dredge Co. in the same county. Plans have been prepared for still another of the same size for the Yukon Gold Co. in the same field. The present tendency is toward extensive yardage in dredging operations, so the new machines are much larger and more powerful than those built formerly.

Idaho

The most spectacular occurrence of the year in Idaho was the development of the Consolidated Interstate-Callahan mine, which was practically unheard of at the beginning of the war, into the third largest zinc producer in the country, being exceeded only by New Jersey Zinc and Butte & Superior. Under the stimulus of a runaway zinc market this property paid dividends in 1915 of $2,530,000, with a single disbursement in August of $960,000. In the second half of the year a legal fight for control of the Consolidated Interstate-Callahan developed, and application was made for a receiver. An injunction restraining the appointment of a receiver was asked for, and the legal tangle still continues. The control of the Ray-Jefferson was secured by the Day interests, and this seems to have a considerable bearing on the future of the Interstate-Callahan, on account of the fact that the two properties adjoin and the Interstate-Callahan tried to secure control of the Ray-Jefferson stock.

A controversy between the Hercules Mining Co. and the American Smelting and Refining Co. regarding the terms of renewal of the smelting contract for the Hercules ore resulted in a deadlock, and the Days, who controlled the Hercules, closed the mine and later secured control of the Northport smeltery situated in the State of Washington, near the Canadian line. The rehabilitation and reëquipment of this plant for the treatment of Hercules ore and custom ores are nearly completed. This brought to the forefront the renewal of the contract between the smelting company and the Bunker Hill & Sullivan Mining and Concentrating Co., with the result that the Bunker Hill & Sullivan announced its intention of building a $1,000,000 lead-smelting plant in the Cœur d'Alenes, if satisfactory freight rates and smoke easements could be secured; otherwise on the Pacific Coast. Work of drawing the plans and working out the design of this plant are well under way, although where it will be situated has not been announced.

If the Northport and the Bunker Hill & Sullivan smelteries fulfill expectations, there will be an important and favorable extension of the ore market for the producers throughout the Cœur d'Alene district.

The most important geological result of the year in the Cœur d'Alene was the development of good ore, both zinc and lead, in the Prichard formation, which is the deepest formation of the district and was considered at one time of doubtful value as an ore bearer. The state mine inspector is quoted as saying that this development will result in expanding the productive area of the Cœur d'Alenes not less than 100%.

Almost every mill in the Cœur d'Alene district is equipped with flotation units. At the Trail smeltery in British Columbia, the new electrolytic zinc plant is practically completed and ready for operation, which is expected to have a considerable effect on the market for zinc ores produced in this district.

Owing to the stimulus of high metal prices, practically every mine in Idaho that has been idle has resumed operations, and although the Cœur d'Alene has attracted the lion's share of attention, all of the other districts have been stimulated. In the region immediately surrounding Boise 1,000 men are employed where last year there were not to exceed 100. A new railroad built into this district for the purpose of opening up large timber tracts affords an outlet for the ores to Salt Lake, so that medium-grade concentrates may now be handled.

Michigan

The history of Lake Superior copper mining[2] during the year can be briefly but accurately summed up in the simple statement of the unprecedented efforts of all operating companies toward maximum production. When navigation opened in the spring, there was no accumulation of copper, all-rail shipments were continuing heavy, and trains of 1,000,000 lb. of copper were not uncommon. When lake navigation closed at the end of the year, the heavy all-rail shipments were resumed.

The attempt of the Western Federation of Miners to cajole Finnish miners to join their union failed, and the Socialist agitators, after subtle hints of deportation, left the district, thus closing the incident which at one time had a nasty look.

[2]A detailed review will appear in the "Journal," Jan. 15.

Whereas most of the mines on the Marquette, Menominee and Gogebic iron ranges of Michigan were forced to curtail operations in the summer and fall of 1914, business started to pick up during the early part of 1915. There was plenty of labor, and no difficulty was experienced in getting men. Many of the companies had cut wages 10%. Now, however, there are twice as many men employed in and about the mines as at this time a year ago, and the old wage scale has been restored; there are practically no idle men on the ranges; and a labor shortage is expected before spring.

The demand for iron ore was brisk after the shipping season had been opened for about a month. The boats had difficulty getting all the ore down the lake, many freighters being attracted by the high rates being paid for carrying grain. Prices for iron ore were the same as in the year previous, but an advance of 75c. per ton has already been announced for 1916. Many stockpiles that had been at the mines for several years were loaded and shipped, and operators had the best season they have had for several years. The prospects for 1916 are bright.

All of the charcoal-iron furnaces in the Lake Superior district are running at a satisfactory rate. The Cleveland-Cliffs Iron Co. is adding 20 retorts at Pioneer Furnace, Marquette, which will give better results in the byproduct department. The sulphuric-acid plant is to be enlarged. There is also a plant at Newbury, one at Gladstone, one at Manistique and one at Stephenson, all of which are in blast; the furnace at Ashland, Wis., is also running. The Jones furnace, at Marquette, which was touted to revolutionize the iron business, has been idle for months.

Machines for loading ore into cars underground are being given serious attention in this district. A large loader worked in the Judson, at Alpha, for some months, giving good results, and one of these machines is now working satisfactorily underground in the Mass, at Negaunee.

Electricity is fast replacing steam in many of the mines. The Peninsula Power Co. is extending its lines in the Crystal Falls district in order to accommodate the mines there, and is adding to its main plant on the Menominee River and its substation at Iron River. The Cleveland-Cliffs Iron Co. is getting ready to erect a new hydroelectric plant on the Dead River, north of Negaunee. The plant on the Carp River will not be large enough to take care of all the mines when the new ones are ready to use current.

Minnesota

There has been a continual increase in the demand for labor on the Minnesota ranges during the year, accompanied by an advance in wages, until now practically the same conditions exist regarding wages as prevailed in the record-breaking year of 1913. It will be a busy winter, with good wages all over the iron ranges and plenty of work.

There has been a largely increased demand for the Cuyuna Range manganiferous ores. Owing to the embargo on shipping, as a result of the war, and the consequent high ocean freight rates, consumers have been forced to give more attention to domestic sources of manganese ores. During the winter manganiferous ores will continue being shipped all-rail from the Cuyuna Range and a considerable amount will be stockpiled.

No direct state legislation of any moment has been directed toward the mining industry, but the new seamen's law, passed by the last Congress, has hampered ore

transportation to a considerable extent and has made transportation costs higher.

The tax disputes between the mining companies and the village officials of Hibbing were finally adjusted on Nov. 23. Several of the largest taxpaying companies had refused to pay their taxes on account of the extravagant and wasteful disbursements of the Town of Hibbing. After suits, threats, injunctions and recriminations, the mining companies paid their back taxes, the village agreed to limit its expenditures to reasonable amounts per month, and the $1,900,000 tax levy for 1916 was abandoned.

On Nov. 1, by order of the Indian Commissioner, all saloons in Chisholm, Hibbing and other Mesabi Range towns were closed; all in the Cuyuna Range had been dry for a considerable period. Mine operators in general favor this application of prohibition to these mining communities.

Mining activity on the Minnesota ranges has exceeded anything in the past history of the ranges except the banner year 1913; almost without exception, properties have gone on a maximum-production basis, and the Cuyuna Range for the first time in its history shipped over 1,000,000 tons. No material changes were made in railroad facilities. The ratio of tonnage going to the two carriers remained the same as last season—85% to the Soo line and 15% to the N. P.

Announcement has already been made of an advance of 75c. per ton in ore prices for 1916, and some of the big independent producers are holding out for a higher figure and fully expect to get $1. The prospect is bright for a banner production, although a shortage of lake-transportation facilities is faced.

The Minnesota Steel Co. resumed construction on its steel plant at Duluth and began the manufacture of steel billets. The Duluth & Iron Range R.R. let contracts for a new $1,500,000 steel and concrete dock, at Two Harbors, to replace its old No. 3 wooden dock, which will be dismantled. In anticipation of the greatly increased tonnage next season, the railroads that haul iron ore to the dock at the head of Lake Superior have placed large orders for heavy locomotives and steel hopper ore cars to handle the traffic.

Missouri

Owing to the extremely high prices paid for Joplin zinc concentrate and for "jack"[3] a great deal of unrest occurred among the miners of the district. This feeling, fostered by the Western Federation of Miners, who believed the time ripe for an invasion on the Joplin district, resulted in a strike, called June 28. Several of the large producers shut down for a period of two weeks and asserted that they would remain closed indefinitely rather than deal with the Western Federation. At its height 5,000 lead and zinc miners were involved in the strike, which, however, fell to pieces and the mines resumed with full working forces on July 12, the defeat of the unionizing movement having been complete. At present the camp is still, as it always has been, an open-shop camp, and the wages are in excess of $4 per 8-hr. shift.

The railroads have been fighting hard for an increase over the 2½c. passenger rate now in effect, but thus far without avail. The Interstate Commerce Commission has, however, granted an increase in freight rates on zinc and lead ores, pig lead, etc.; the advance on coal amounting to 50c. per ton from the Kansas field to Joplin. There have been but slight increases or additions in transportation facilities, the railroads being loath to spend any money without an increase in rates.

The state, in conjunction with the United States Government, has done much good work to improve sanitary conditions for the miners, based largely on the research work conducted by Dr. A. J. Lanza, and Edwin Higgins,[4] of the Bureau of Mines.

A number of laws were passed relating to the dust-allaying methods to be used in lead and zinc mines and compelling the construction of change and wash houses.

There has been no other important legislation directly affecting the mining industry, although several near-by states have introduced the workingmen's compensation law and prohibition.

In southeastern Missouri the Mine La Motte Co. has installed steam shovels and is operating a washery for concentration of the lead found in surface clays.

Among the interesting developments in the Joplin district during the year were the experimentation done with flotation, leaching, electrolytic precipitation, and the attempt to convert second-grade concentrates into a high-grade roasted product, from which high-grade spelter, rivaling the New Jersey Zinc Co.'s Horsehead and Bertha brands, could be made.[5]

Montana

The year 1915 witnessed the most remarkable progress by the Anaconda Copper Mining Co. in its Butte mines and in its reduction works at Anaconda and Great Falls. At an expense estimated at $6,000,000, the Washoe smeltery capacity was greatly increased; a new roaster plant was installed; a new reverberatory plant was built; the oil-flotation process was installed in the remodeled concentrator; a sulphuric-acid manufacturing plant was erected; and a score of lesser improvements were made. At the Great Falls plant, at an estimated cost of $1,350,000, an electrolytic copper refinery was built with a capacity of 15,000,000 lb. per month, and radical changes were made in the reduction works there.

At the beginning of the year the payroll was on a basis of $3.50 per day on a 5-day a week schedule; at present the scale is $4 per day with a 6-day schedule. The monthly payrolls January, 1915, were $400,000; at present they are $1,150,000.

An increase of 20% in the ore that can be handled at the Washoe and Great Falls smelteries is expected after Feb. 1, 1916, and this will necessitate working all the Butte mines at capacity. The present average daily production of 13,600 tons will be increased to 16,000 tons. Fully 40 mi. of crosscuts, raises, drifts, winzes and shafts make up the development work of the year.

At the present time the Nettie, Alice, Emma and Lexington, four well-known old mines, whose ores are high in zinc and silver, are being unwatered and put in condition to operate; work being rushed to secure, in particular, the zinc ores.

The concentrator at the Washoe smeltery was remodeled and oil flotation was installed, which has reduced the

[3]Dealt with at length in the special article on the Missouri zinc industry elsewhere in this issue.

[4]Technical Paper 105, Bureau of Mines, "Pulmonary Disease Among Miners in the Joplin District, Missouri." "Eng. and Mining Journ.," Dec. 11, 1915, p. 976.

[5]A considerable amount of mill construction in the zinc-lead district is given in detail under construction news elsewhere in this issue.

copper left in the tailings to 0.1% against 0.65% under the old plan.

The zinc experimental plant at Anaconda (no longer experimental) is a success and is making 5 tons of zinc per day. A larger plant will be constructed in 1916.

Among the properties developed or in course of development is the Tropic, situated 2 mi. east of Butte and owned by the Anaconda company. About 75 tons of ore per day is being shipped from this mine. Arrangements have been made for the Anaconda company to develop the ground belonging to the South Butte Mining Co. and lying south and west of the Belmont mine. A crosscut is being driven into this property from the 2,800 level of the Belmont.

At the Emma mine the work of unwatering the shaft is progressing rapidly. The crosscut from the 1,800 level of the Original has now been run 2,000 ft. south in the direction of the Emma. The Lexington, which has a shaft 1,400 ft. deep, has the water down to the 650 level and about 2,000 ft. of the old drifts cleaned out and retimbered. The Moonlight is installing a new electrical hoist—capacity 24,000 lb. from a depth of 2,500 ft.

Anaconda's production increased from nearly 14,000,000 lb. in January to over 22,000,000 lb. per month in the middle of the year.

The most remarkable development in mining in the Butte district during the year 1915 has been the progress in the production of zinc ores. At present Butte has the second largest zinc producer in North America, the Blackrock mine of the Butte & Superior.

During the year the Butte & Superior produced approximately 165,000,000 lb. of zinc. The lowest month's production was in June, when it amounted to 11,815,583 lb. The month of November passed the 16,000,000-lb. mark. The increase in tonnage during the year was from 36,840 tons in January to 52,360 tons in November. The shaft of the Blackrock mine was sunk during the year from a depth of 1,640 to 1,920 ft. and stations were cut on the 1,700 and 1,900 levels. The present ore reserves are estimated at over 1,000,000 tons, or two years' supply at the present rate of treatment. About 4 mi. of crosscuts and raises were completed.

During 1915 Butte & Superior completed the installation of the new oil-flotation plant, in which are 60 new Janney machines. With the improved machinery, the recoveries were increased from 91% to 95%. The output of the mill, which was figured at 1,000 tons per day, is 50% in excess of that. The difficulty encountered early in the year of finding smelting facilities to handle the output was finally overcome, and all the concentrates the mill can turn out are now being handled.

The Clark mining interests in Butte have confined their efforts during the past 12 months to the further development of their zinc properties. At the Timber Butte mill, which started operating in June, 1914, many improvements have been made that W. A. Clark, Jr., states have brought the recoveries up to 95.5% on the average, and they make a much better showing than that in some instances.

The mill now has a capacity of approximately 5,000 tons of concentrates a month, although it has been turning out only about 4,000 tons, as the contract with the smelters limited the amount from the Timber Butte mill to that figure. After Jan. 1 they expect to increase their output to capacity. All the ore handled is taken from the Elm Orlu, where sinking and cross-cutting sufficient to keep fully three years of ore reserves ahead have been carried on during the last year. The Elm Orlu has let a contract for the installation of a new electrical hoist similar to that at the Granite Mountain.

The 2,000-ft. shaft that is being sunk on Clark property in the Northwest section is being put down with the primary object of increasing the zinc output, and should large bodies of zinc ores be opened there as the engineers expect, the Timber Butte mill will be kept busy making concentrates from the Clark mines alone.

The output of zinc in concentrates per month runs about 4,000,000 lb. from the Timber Butte mill—about a quarter of the output of the Butte & Superior mill.

Should the zinc plant of the Anaconda company prove its success to the satisfaction of the Clark interests, a plant to make zinc will be installed by them in Butte.

In addition to the Butte & Superior, Anaconda and Clark interests, it is understood that the United States Steel Corporation has secured options on valuable zinc-mining properties in the Butte district and may enter this field.

The East Butte Copper Co. has started up its new oil-flotation plant with satisfactory results. It possesses two advantages due to recent advances made in Montana—it will secure its sulphuric acid from the large sulphuric-acid manufacturing plant of the Anaconda company, and it will secure cheap electric power from the immense hydro-electric developments of the Montana Power Co. The capacity of the new plant is 400 tons of ore per day. There are large quantities of tailings on the dump at the Pittsmont smeltery, containing considerable copper, which will be re-treated in the new oil-flotation plant, where also it is possible to handle at a good profit large available bodies of low-grade ore.

Improvements made at the smeltery during the past year include the rebuilding and enlarging of the blast furnaces, which puts the East Butte in a very advantageous position. It is now handling only the ores of the Butte-Alex. Scott mine and of its own mines, but will be able to care for considerable custom ore from near-by mines. Its production during the coming year will probably run close to 2,500,000 lb. of copper per month, or 30,000,000 lb. for the year.

The contract work for the development of the North Butte Extension has been completed. This included drifting along the Overland claim and crosscutting the width of the claim on the 1,200 level from the Blackrock. The new ore reserves are maintaining the old averages of silver—about 20% zinc and 7 oz. of silver.

The Butte & Great Falls is sinking to the 500 level and is crosscutting on the 300, where the lead has been cut. The Butte-Duluth went into the hands of a receiver early in the year on account of financial difficulties, from which it was not extricated until late in December, when a working arrangement was made with the East Butte, by which operations can be resumed under direction of the latter company, which has financed the former's indebtedness. The ultimate consideration is said to be 55% of the stock. The Butte-Alex. Scott has installed a new headframe, a new double-drum Nordberg hoist, round cable and skips.

The leaching plant at the Bullwhacker mine was not operated, but in the latter half of the year considerable copper ore was shipped from this property. The North

Butte produced nearly 8,000,000 lb. of copper during the first half of the year and considerably increased the rate of production toward the end of the year, as did other copper mines in the district.

The dissolution of the Amalgamated Copper Co. did not affect the Butte mines control, although local pride was gratified by the fact that the Anaconda became the nominal, as well as the actual, leader.

A workingmen's compensation law was put into effect in Montana during the year, the adoption of different clauses of which was optional with the mining companies. There was no unanimity among the mining companies in their choice of the optional clauses of the act, but it has seemed to give general satisfaction.

The most serious accident in the history of Butte mining occurred on Oct. 19, when 13 boxes of dynamite about to be lowered into the mine exploded at the collar of the Granite Mountain shaft of the North Butte Co. Sixteen men were killed and several severely injured. The cause of the accident has never been determined, despite careful investigations.

The annual report of the state mining inspector gives the present monthly mining payroll in Silver Bow County as approximately $1,750,000 and the number of men employed as 14,067.

Montana oil and natural-gas fields received a great deal of attention during the year; many producing wells were brought in, and much promising prospecting is being done.

Nevada

Labor and wage conditions throughout Nevada remain practically without change. A threatened strike at Ely, owing to an edict for compulsory physical examination of employees by the Nevada Consolidated, was finally averted by the company withdrawing the order.

Except for the larger companies which had long-time sliding-scale contracts, the zinc-ore market has been rather restricted, but for these companies their ores have been marketed at a very considerable profit during the high price of spelter. Following the increased activity in Goldfield and surrounding country, the Western Ore Purchasing Co. reopened its sampler at Goldfield, thus affording a quicker and more convenient market for the small shippers of gold ores.

Motor trucks are displacing wagon transportation wherever roads will permit, but in districts like Aurora and Fairview bad weather compels the laying up of the motor truck and the return to 12- and 16-horse and mule teams for freighting. The Aurora haul is 60 mi. Motor haulage has not always lessened transportation costs, however, owing to poor roads made worse by increased heavy traffic.

An incipient boom followed the discovery of free gold in a bold outcrop at Willard, a few miles from Lovelock, and a small mushroom tent city sprang up. The boom died a-borning, however, and the camp is now all but deserted. The search for good prospects, both for the precious metals and rare metals, is becoming keener, but no important discoveries have been made except in the case of tungsten. The greatest activity in this has been in the Snake Range, in the eastern part of White Pine County. Four mills are operating, concentrating scheelite and hübnerite, making concentrate averaging about 60% WO_3. In the vicinity of the United States Tungsten Co.'s property, 12 mi. south of Osceola, both north and south of their mill a great many locations have been made, the discovery work on these claims invariably showing tungsten ore. Probably 300 men are working on tungsten properties in the county.

The Nevada Consolidated Copper Co. ran on a 50% basis during the first six months of the year, but during the last six has produced 10,000 dry tons daily. Flotation experiments are being carried on at the concentrator, and at the smeltery and power plant a quarter of a million dollars has been spent on increased capacity and new equipment. The Ruth mine has been started up on a 1,000-ton daily capacity, to be gradually increased to 3,000 tons, mined by underground methods. Steam-shovel operations are running smoothly. The two pits, Eureka and Liberty, are gradually being connected. No work has been done on the Consolidated Copper Mines (old Giroux) except some ore taken out by the Nevada Consolidated from the Ora claim, as the Nevada Consolidated work necessitated. The old Victoria copper mine, 15 mi. northeast of Currie, on the Nevada Northern R.R., has been bonded, and some ore has been shipped to Salt Lake, motor trucks being used for hauling to the shipping points.

The Good Springs district has witnessed considerable construction of small mills, mostly of the dry concentrating type. Several sales of property, from $30,000 to $50,000 each, have been made. Important orebodies of lead-zinc ore were discovered in Green Monster, Mobile, Bonanza and Sultan mines, and a new shoot was opened in the Yellow Pine. Vanadium ore of good grade was discovered on the Christmas property, and a considerable tonnage of vanadium ore is blocked out in the various mines in the district. No production of platinum from the Boss mine was made, as the mine has been under option throughout the year on terms which did not permit shipments to be made.

The zinc-carbonate calcining plant at the Potosi was greatly improved, and dry concentrating plants using Stebbins tables were constructed at the Bullion, Anchor and Sultan mines, and a plant using Sutton, Steele & Steele tables was erected at the Frederickson mine. All of these plants are of about 60 tons' daily capacity.

The Rochester and Nevada Packard mills both went into operation, and for the periods operated made heavy production. Important alterations were made at the Aurora mill, and bullion shipments were far in advance of those of 1914. The Pittsburgh Silver Peak at Blair practically exhausted its orebodies and began the examination of a property in California to which they will move the Silver Peak mill if the examination justifies. In Jarbridge the Bluster mill operated to capacity, and in the Manhattan district five mills were operating, one of them treating 150 tons per day.

On the Comstock lode healthy and continuous operations were carried on with satisfactory, but not startling, results, although the silver production decreased.

The Mason Valley smeltery was idle during the year. The Nevada-Douglas proceeded with the construction of a leaching plant, and late in the year operations were started.

Pioche for the first time in 40 years entered the dividend-paying list on the strength of distributions made by the Prince Consolidated, which was shipping at the rate of 12,000 tons per month in October. The Amalgamated Pioche also made important shipments, as did a number of the smaller properties. There was considerable activity

in mill building, and prospects for the district for 1916 are bright.

Apex litigation threatened, at one time during the year, to involve all the important properties in Goldfield, but finally amicable adjustments and side-line agreements were made, and all suits were withdrawn. Tonopah also was afflicted with serious apex litigation.

New Mexico

The Lordsburg district during the year made a total production of approximately 105,000 tons, valued at $800,000, which is double the tonnage of any previous year in the history of the camp. Production in this district was stimulated by the advent of the Arizona & New Mexico Ry., which built a spur into the Virginia section of the district. This eliminated the 3-mi. wagon haul to Lordsburg, formerly done by freight teams and later by tractors, and reduced haulage costs approximately 50% and made shipping advantageous all the year around, whereas winter weather had rendered hauling an impossibility before.

During the year two important mining transactions were effected. The Atwood mine was purchased by the 85 Mining Co., and diamond drills which were immediately put to work resulted in the discovery of new orebodies which warranted a continuation of operations at the Atwood shaft. Late in the year Silver City capitalists and mining men associated with the Chino Copper Co. came to the assistance of the Bonney Mining Co., took care of its indebtedness, refinanced the company and it is expected will place it on the producing list early in 1916.

The 85 Mining Co. added largely to its ore reserves by development work and installed many surface improvements. During the summer of 1915 a dry lead concentrator was erected on the Waldo group, but owing to the hardness of the ore, the work was abandoned. At Lee's Peak the Octo Mining Co. erected a hoist house and headframe and is prepared to sink a shaft 500 ft. deep. Along with the Battleship group, it made several carload shipments of ore to the El Paso smeltery. In the Leidendorf camp, surface ores which were sorted, and high-grade pockets underground in various properties, provided several carloads of ore which were shipped to El Paso and Douglas.

The Santa Fe Gold and Copper Co. at San Pedro resumed operations with 300 men and treated a considerable tonnage. The matte produced was shipped to Omaha.

The old Cochiti mining district was rejuvenated by the Cossak Mining Co., which built a 100-ton cyanide mill at Bland that has been in successful operation throughout the year on ores from the mining property formerly owned by the Navaho.

The Burro Mountain Copper Co., at Tyrone, continues making extensive surface improvements. It has laid out town sites, installed a new headframe and practically completed its 1,000-ton concentrator. Production is expected to begin shortly after the first of the year. The capitalization of the company was increased during the year from $200,000 to $8,000,000.

Two new concentrating plants added to the activity in the Pinos Altos mining district of Grant County. The Empire Zinc completed and put in operation its new 100-ton electrostatic concentrator during the latter part of November. Stauber & Wright, lessees of the Savanna Copper Co., have been successfully treating their ore in an electrostatic concentrator for several months. The Meeker Mining Co., incorporated late in the year, began work preparatory to the sinking of a three-compartment shaft on its property. Some development work was done on the Silver Hill property by the B. V. N. Mining Co.

In the Hanover section, the Empire Zinc continued regular shipments of zinc carbonates and put down a three-compartment shaft on the Thunderbolt claims, where zinc sulphides are encountered. A new power house and electrostatic mill were built at Hanover which will start operations early in the year. The United States Copper Co. did little work except the annual assessments, but the management announced that the coming year will see the properties operated on a substantial scale. At Fierro the Phelps-Dodge Co. and the Colorado Fuel and Iron Co. ceased operations. However, the latter company is making preparations for the resumption of mining.

The Chino Copper Co. has produced steadily at the rate of 7,000 tons of ore per day, which easily makes it the largest producer in the state. The total assessed valuation of the company for the current year was $4,062,252, the company now paying one-fifth of the total taxes of the county in which it is situated. Flotation experiments are being made in the mill, and many improvements were made at the power house and the assay office. In July the Chino increased the wages of its employees 10%, owing to the advance in copper prices.

The Mogollon district continued the most important gold-producing district. Several important transfers of mining property took place, of which probably the most important was the acquisition by the Mogollon Mines Co. of the Ernestine property. This company built a large storage dam which will impound 1,250,000 gal. of water, which should be sufficient to meet the needs of the milling plant during the period of low water in the summer. A large amount of new equipment was installed. The controversy with the Arizona farmers over the disposal of tailings from the Mogollon mill was apparently settled by the Socorro Mining and Milling Co. and the Mogollon Mines Co. jointly installing impounding reservoirs and a system of launders whereby all tailings are kept out of Mineral Creek. A bridge is being built over the Gila River which will aid in the transportation of Mogollon ores and freight.

In the Red River district, Taos County, the Buffalo-New Mexico Mining Co. and the Memphis Red River Mining Co. both did considerable shaft sinking and opened up some good ore. Milling was done at several Red River plants, and quite a tonnage of smelting ore was shipped to Pueblo.

The New Mexico Legislature put into the hands of a state tax commission the regulation of mining taxation. All surface improvements will be taxed. All nonproducing mining claims known to contain valuable deposits will be assessed, and producing companies are to be taxed on their output.

New York

Stagnation marked the iron-ore industry in New York State during the year up until September, when renewed activity in the ore market stimulated mining conditions, and during the months of October and November iron-ore shipments from the Mineville district were at the rate

of over 1,000,000 tons a year. During the summer season there was a considerable shipment of lump ore to Canada by boat.

There was an ample supply of labor until the busy season started in the fall, since which time it has been increasingly difficult to get the labor necessary for the increased production.

The Chateaugay Ore and Iron Co. has been sinking a new shaft during the last year, which should be in operation in 1916. It has also made extensive repairs to the separating mill. The Witherbee-Sherman Co. made extensive improvements at its Old Bed, Harmony and Barton Hill mines, the latter of which will begin producing early in 1916. The hoisting and transportation system at the Harmony mine was entirely changed and a new system installed. Since the revival in the ore market in September especial attention has been paid by this company to the development of low-phosphorus ores.

Oregon

The most important mining operations in Oregon at the present time are at Cornucopia and in the vicinity of Mormon Basin. The Rainbow mine, for a long time under option and development by the United States Smelting, Refining and Mining Co., has reverted to the Rainbow Mining Co., which will continue operations on a large scale.

Important development has taken place in the Cornucopia district, in the Last Chance and Union-Companion mines, where the orebodies on the lower levels show considerable improvement over the good ore already developed in the levels above. The production for the coming year will be greatly increased.

Dredging is being successfully carried on by the Powder River Gold Dredging Co., near Sumpter, which has built and placed in commission a second boat during the year.

A short railroad, built from Grant's Pass, southwest into the Waldo district, although completed for only 15 mi., has lately stimulated development on some copper deposits in that region.

Early in the year a lease was negotiated by the state to Jason C. Moore, of New York, for the treatment of the waters of Summer and Abert Lakes, in Lake County, for their sodium and potassium contents. This project involved the construction of a 270-mi. pipe line to the Columbia River, the construction of a large hydro-electric plant and the total investment of about $7,000,000. Construction work was held up on account of conflict with some government conservation project, which trouble is expected to be removed by legislation at the present session of Congress. Work will then be resumed on this project.

South Dakota

The only change of importance in the local ore market during the year was the reduction by the Mogol Mining Co. of $1 per ton in their treatment charge on custom ores. This will stimulate mining and leasing.

The discovery of wolframite in the district at a time when the demand for tungsten was strong and the market price climbing made this look attractive, although the production was insignificant compared with the gold produced. Several carloads of hand-sorted ore were shipped and marketed.

The most important of the wolframite producers are the Wasp No. 2 at Flatiron and the Homestake at Lead. Both are making regular shipments. The ore in both cases is found in the flat formation lying on the quartzite and varies in grade from 5 to 62% tungstic acid.

At the Wasp, where several thousand tons of lower-grade ore have been broken, a concentrator has been constructed and put in operation. Several hundred tons of the higher-grade material have been hand-sorted and shipped. The gold production from this property will be considerably less than during the year previous, but the total production of minerals will show a decided increase over the year 1914.

The Homestake developed the tungsten deposit in the Hidden Fortune ground. All of the ore so far taken out is hand-sorted and shipped. Between Keystone and Hill City there has been activity in the development of tungsten properties, and nearly all the smaller properties are being worked, although production has not been large. The Black Hill Tungsten plant is being repaired and put in shape for the handling of tungsten ore. At the Golden Reward, at Spokane, wolframite deposits are being developed.

Regular shipments of amblygonite were made from the Rheinbold and Kamman properties. Scrap mica found a ready market at $13 per ton f.o.b. cars Keystone, but the production has been limited. Several of the larger operators in this district made preparations to resume work, and the incoming year should be an active one.

At the Homestake property heavier stamps are being used and a different type of open back mortar has been adopted. The 1,850 level, the lowest working in the mine, has been opened up and is now being worked. The Golden Reward company started a roaster during the summer, and it has been in continuous operation since. After this preliminary treatment the ore is cyanided at the Deadwood plant. The Trojan company has added to its mill equipment and increased its capacity. The Rattlesnake Jack company at Galena completed its 10-stamp mill and operation was begun, but a dam had to be built to impound the tailings, and during this time the plant was idle. The Oro Hondo continued shaft sinking, the bottom now approaching the 2,000 level. The Mogol company increased its mill capacity and has been in continuous operation on ores from its property as well as custom material.

The Golden Reward mill operated steadily on siliceous ore from its mines, and during the latter part of the year an additional product was sent to the mill in the form of roasted sulphide or "blue" ore. These sulphide ores had never before been treated successfully by cyanidation. Results indicate 90% extraction as compared with 35% without roasting.

Tennessee

War demands for sulphuric acid have stimulated production of the Tennessee acid plants to maximum, copper being in reality a byproduct now, and caused certain additions to be made, data of which are not available. The war having stopped completely the imports of potash, it made a record high figure. The advance in both sulphuric acid and potash has put up the price of complete fertilizer and bulk acid phosphates, so that Tennessee phosphate properties have been stimulated both as to production and as to efforts to decrease metallurgical losses, to which end mechanical classifiers and thickeners, particularly of the Dorr type, have been installed to cut down

tailing losses. Only one sale of phosphate property of importance was negotiated during the year, and the price was high compared with previous transactions, owing to the influences just mentioned. The zinc industry was stimulated by the high price for spelter, but nothing of a special note occurred except the erection, by the American Zinc Co., of a zinc-concentrating mill, at a cost of $100,000.

Utah

No labor troubles, except an inconsequential strike of 14 days' duration at Park City, disturbed Utah mining activities during 1915. The labor supply has been plentiful, and in the copper camps wages were advanced with the advance in metal prices.

The valley smelters, United States, Murray, Garfield and International, bought ore, and various other ore buyers were in the field, among which were representatives of Beer, Sondheimer & Co., purchasing zinc ore; Consolidated Ores Co., agents for Edgar Zinc Co. and general rare-metal ore business; Knight & Warnock, cyanides, precipitates and ores; and the Empire Zinc Co., for zinc ores.

Work has been started on an 8-mi. narrow-gage railroad from Wasatch to Alta, in Little Cottonwood, which will connect with the Salt Lake & Alta R.R., at Wasatch. The road is to cost about $65,000, of which $22,000 has been raised.

Corporation taxes have been slightly changed and made more specific. At present mining property is taxed at the price paid the United States, and net annual proceeds are determined and taxed by the state board of equalization.

The Utah Metal and Tunnel Co. at Bingham took over the adjoining Bingham-New Haven Gold and Copper Mining Co.'s ground. The United States Mining Co. bought the Aetna group of mining claims southwest of the Last Chance, in Bingham. The Utah Consolidated at Bingham bought the Copper Boy group of claims adjoining this ground. The Eagle & Blue Bell at Tintic acquired the Victoria property. The A., S. & R. Co. bonded the Lakeview Mining Co.'s zinc property on Promontory Point for $625,000. The United States Smelting, Refining and Mining Co. took a bond on the Lumry & Moore claims at Fortuna in Beaver County and started work.

The Cardiff in Big Cottonwood developed a large body of carbonate lead-silver-copper ore and began production and payment of dividends. The South Hecla at Alta made important ore discoveries and developed into a regular producer. The Sells, adjoining the South Hecla, developed a new orebody carrying silver and some lead. Important zinc deposits were discovered and developed on Promontory Point, 30 mi. west of Ogden; and a new zinc camp, with 15 properties doing development and employing upward of 130 miners, was started. The Lake View Mining Co. in this camp paid approximately $45,000 in dividends by the end of the year. Gold discoveries were made at the new camp of Fortuna in Beaver County and at Goldstrike in Washington County. The Utah Metal and Tunnel Co., of Bingham, on Apr. 11 discovered a large body of shipping ore. This orebody, carrying lead, silver, gold and copper, is estimated to be worth between half a million and a million dollars. The Eagle & Blue Bell at Tintic developed an important lead-silver orebody between the 1,550 and 1,780 levels. The Yankee at Tintic made a new strike of what appears to be an important body of silver ore.

Flotation was installed by the Utah Copper to clean concentrates. Flotation was installed by the Utah-Apex at Bingham to replace vanners, using the Janney process, and a 92% extraction was made. The Daly-Judge at Park City installed flotation to re-treat tailings and slimes, using the Callow process. The Silver King Coalition at Park City is installing a flotation plant of 60 to 100 tons' capacity daily. New mills were built at or below Park City to treat tailings, by the Big Four Exploration Co. (concentration), 250 tons' capacity, and the Broadwater Mills (straight concentration), 500 tons' capacity. A mill to treat tailings from the Horn Silver was built by the Caldo Mining Co. at Frisco in Beaver County, using the Callow process. The Utah Leasing Co. built a mill to treat a 1,000,000-ton tailing dump from the Cactus mill (South Utah) at Newhouse, using the Minerals Separation process; capacity 500 tons a day. This mill is operating and making a successful saving on tailings carrying from 0.7 to 0.8% copper. A new mill is being built by the Knight-Dern interests at Silver City to treat low-grade ores, from the Tintic district, by chloridizing roasting and leaching. The Utah Ore Concentrating Co.'s new mill at Tintic is treating dump ore from the Chief Consolidated, Eagle & Blue Bell and Victoria.

The United States Smelting, Refining and Mining Co. at Midvale enlarged its wet concentrator from 350 to 600 tons' daily capacity and made a corresponding enlargement of the Huff electrostatic plant. This company increased its roasting capacity by the addition of Dwight-Lloyd roasters and added to its baghouse. The company is making metallic cadmium as a byproduct from fluedust by an electrolytic process. The A., S. & R. at Murray installed Dwight-Lloyd roasters. The Garfield Smelting Co. equipped its reverberatory furnaces to burn powdered coal instead of oil. Both the United States and the A., S. & R. are experimenting on electro-chemical processes for the recovery of zinc.

There has been practically no production of uranium and vanadium ores from Utah since the war started and cut off the market. Development work on carnotite properties in San Juan and Grand Counties has been done and claims have been patented. A few odd lots of ore which were on hand have been sold in the United States for experimental purposes.

The demand for tungsten has been good. A small amount has been produced from scheelite and hübnerite, chiefly from Nevada and Idaho, and marketed here.

A limited tonnage of antimony ore was shipped from southern Utah near Marysvale and from Nevada—Carlin, Battle Mountain, Winnemucca, etc.—to Salt Lake, although most of it was shipped to the Pacific Coast. Small amounts of bismuth ore have been shipped from Deep Creek. There has been no production of molybdenum ores, although there is more or less molybdenite and lead molybdate in Alta, which, however, would have to be closely sorted or concentrated.

The production of lead ore has been normal or greater than normal, but probably not as great an increase as generally expected. There should be an increased tonnage from Park City, Bingham, and also most of the other camps, excepting perhaps Beaver County. More zinc ore has been produced than ever before in Utah, probably twice as much. There has also developed a good

market for substantial tonnages of high-grade zinc sulphides (above 40%), as well as for carbonates. Most of the Utah zinc ore is shipped to the Kansas-Oklahoma gas belt. Shipments are also made to Pennsylvania.

The production of potash was started in Utah in the fall by the Mineral Products Corporation at Marysvale, in the southern part of the state. The ore is alunite, and the process consists of crushing, roasting, leaching with water and recovery of the potash as sulphate by evaporation.

A new powder plant of the Hercules Powder Co. at Bacchus, near Garfield, was built and began manufacturing dynamite and black powder for the Intermountain country in March. This plant has manufactured its own sulphuric acid for use in making its nitroglycerin.

During the year the total production from Bingham is estimated to have been 10,176,984 tons, compared with 7,800,661 tons the year previous. The smallest month's production was January—460,125 tons—and the largest August—1,029,763 tons. There were 33 shippers, compared with 29 the year previous. The Utah Copper was of course the premier producer.

During the first 11 months of the year Park City shipments amounted to 91,477 tons, compared with 62,606 for the year previous. There were 18 shippers, compared with 12 the year previous; the Silver King Coalition, the largest shipper by far, sending out about 40,000 tons, compared with 29,000 the year previous.

Tintic ore shipments for 11 months totaled 6,003 cars, compared with 5,824 cars the year previous. In 1912 shipments for the first 11 months of the year totaled 8,819 cars, since which time Tintic shipments have steadily declined until this year. There were 40 shippers, compared with 41 last year, of which the Chief Consolidated was first with 1,010 cars and the Iron Blossom and Centennial Eureka were second and third.

Utah exceeded all its previous records in the production of every metal mined within the state. The estimated totals were: Gold, 170,836 oz.; silver, 12,512,891 oz.; copper, 174,864,825 lb.; lead, 186,030,225 lb.; zinc, 27,341,830 lb.; arsenic, 1,827,200 lb. The total estimated value of the mineral production of Utah for the year is $52,229,268.

Alaska[5]

The Alaska mining industry as a whole was more prosperous in 1915 than in any previous year. The value of the total mineral output is estimated to have been $32,000,000, compared with $19,064,968 for 1914. The highest value for any previous year was in 1906, when Alaska produced $23,378,428, but this was at a time when the bonanza placers of Fairbanks and Nome were yielding their greatest returns.

The high value of the mineral output in 1915 was due in large measure to the amount of copper mined; estimates indicate this to be 83,850,000 lb., valued at $14,400,000. In 1914, 21,450,628 lb. of copper was mined, valued at $2,852,934. The gold production in 1915 was about $16,900,000, against $15,626,813 for 1914. This is the largest gold production since 1912, when the output was $17,145,951. As the production of silver is incidental to gold and copper mining, this also increased; estimated $400,000 in 1915, against $218,327 in 1914. 1914.

[5]Excerpt from advance statement by United States Geological Survey.

The output of other minerals, including tin, antimony, marble, gypsum, coal and petroleum, in 1915 had a value of about $300,000, compared with $222,802 in 1914.

Placer gold produced in 1915 was $10,500,000, compared with $10,730,000 in 1914. This decrease is chargeable to falling off in output of some of the Yukon camps. Developments in the Tolovana district, where gold was discovered in the autumn of 1914, indicate that this district will become of importance as a producer.

About 42 gold dredges were operated in Alaska during 1915, the same number as in 1914. However, the gold recovered by dredges was less than $2,000,000 in 1915, compared with $2,350,000 in 1914. This falling off is chargeable to the Seward Peninsula districts, where about 37 of the dredges are working. There can be no question that this decrease of dredge output is but a temporary check to the industry as a whole and is owing to certain local conditions. Several dredges that will be operated in 1916 are in process of installation.

About 23 gold-lode mines operated on a productive basis in 1915, compared with 28 in 1914. The value of the gold-lode output increased from $4,863,028 in 1914 to about $6,200,000 in 1915. This increase is to be credited to the Juneau district, where large developments were continued throughout the year. There can be no question that the gold-lode output will increase at a rapid rate owing not only to large-scale operations in southeastern Alaska, but also to the encouragement given to lode mining by the railway under construction from Seward to Fairbanks.

About 200 tons of stream tin was produced in Alaska during 1915. Much the larger part of the tin came from the York district of Seward Peninsula. Here one tin dredge was operated throughout the season on Buck Creek. A new dredge was installed on the same creek during the summer and operated for a part of the season. No returns have yet been received from the two dredges operated in 1914 on Anikovik River, in the same district, but these were probably also operated. These two are working on placers carrying both tin and gold. Developments were continued on the Lost River lode-tin mine, and there was also some prospecting of other lode-tin deposits. There was, however, no production of lode tin.

The only other tin mining was done in the Hot Springs district of the lower Tanana basin. Here considerable tin is recovered incidental to gold placer mining.

The high price of antimony in 1915 led to the mining of over 800 tons of stibnite ores in Alaska; 700 tons from the Fairbanks district, and the rest from Seward Peninsula.

In the Juneau district the four mines of the Treadwell group were operated on the same scale as last year. An accident to the central hoist curtailed the output for several weeks during the summer. The addition of 30 stamps to the Ready Bullion mill is under way. A mill having a daily capacity of about 6,000 tons was completed in February at the Alaska-Gastineau mine and operated for the rest of the year. Power is furnished by a hydro-electric plant on Salmon Creek. Another plant, the Annex power project, is under construction on Taku Arm. The mill of the Alaska-Juneau mine was operated during the year. The construction of a larger mill—a part of the original plan for the equipment of this property—has been begun. This mill includes four units, each having a daily capacity of 2,000 tons. Hydro-electric power is

to be used, supplemented by an oil-burning plant. Developments were continued on the properties of the Alaska Gold Belt, Alaska Taku and Alaska Treasure mining companies, all of which are near Juneau.

Nearly four times as much copper was produced as in the previous year, and the value was nearly five times as much. The copper was taken from 14 mines, of which seven were in the Ketchikan district, four on Prince William Sound and three in the Chitina district.

The enormous output of copper from the Bonanza and Jumbo mines, in the Chitina district, overshadowed all other operations in the Copper River basin. The adjacent Mother Lode mine was, however, also operated throughout the year. Its actual shipments are as yet limited to the winter season, as the ore is sledded to the railway, a distance of 14 miles. Ore shipments from this district were interrupted for several weeks during the summer on account of the burning of several railway bridges.

Mining in Mexico in 1915

Conditions in the Mexican mining camps during the year have been unsatisfactory, perhaps a little more so than during the year previous. In the early part of the year it was expected that there would be a possibility of doing some mining in the principal camps, but owing to the difficulties brought about through labor, transportation and the handling and exporting of bullion, practically nothing was done throughout the country. The prospects for the coming year are particularly good, since the natives seem to have had enough revolution, but much serious work will have to be done before the properties in the interior can go to work again. The railroads are in bad shape, the rolling stock has largely disappeared, and the roadbeds are seriously injured by practically two years of complete neglect. However, it is expected that all energies will be bent upon their repair and the upbuilding of commerce in general, so that there is every hope that, while complete return to normal conditions cannot be brought about within a year, materially important steps can and will be taken.

Aguascalientes and Chihuahua

Very little, if any, work has been done during the year in Aguascalientes; the Tepezala mines were in operation for a few months during the early part of the year, but were closed when operations at the smeltery ceased in February. The principal producers in past years in the Ocampo district were the Aguascalientes Metal Co., Fortuna, and Santa Francisca mines, situated near Asientos. The Boleo mines, at Santa Rosalia, Baja California, belonging to French interests, were in operation during the year. In the State of Chiapas practically nothing was done, though the state is not a large metal producer at any time.

A little work was done in Chihuahua at the Barranca del Cobre mine. The Batopilas property was operated for part of the year, while the Yoquivo mine has been running with reduced force. The Lluvia de Oro did but little work. The Palmarejo & Mexican Gold Fields property, at Chinipas, is installing a new milling plant, but little was accomplished. The Rio Plata property at Guazapares was unable to prosecute active work. The Sententrion property has been offered for sale by San Francisco parties with a possibility of an examination being made. No work was done at the property during the year.

At the Boquillas de Carmen mine the property is reported sold to a company of which F. B. Morehouse is manager. The Gibraltar, Lepanto and Naica properties, and the Ramon Corona mine at Naica were examined during the year. Considerable ore belonging to the Naica company, which was stored at Conchos, was confiscated by the Villa government during the year. The Encinillas smelter at Camargo was in operation and was said to be reducing confiscated ore.

In the Guerrero district the Calera mine at San Isidro passed under the management of the American Smelting and Refining Co. The Alvarado Mining and Milling Co., in the Hidalgo district, operated a 300-ton mill near Parral with ore from the Alfarena, Prescena, Palmilla and Muertos mines, near Minas Nuevas, and from the Alvarado mine, near Santa Barbara. The Veta Colorada property, at Villa Escobedo, was sold at auction to satisfy creditors. In Santa Barbara the Montezuma Lead Co., belonging to the R. S. Towne interests, had a few men employed until October. The Tecolotes mine at the same place was in operation until October, when the foreign employees were all ordered out. El Rayo mine, belonging to the Mines Company of America, was operated until October. The San Francisco del Oro mine, about six miles from Santa Barbara, conducted experiments with the Wood flotation process on its complex sulphide ores. Operations ceased in October.

In the Iturbide district the smeltery of the American Smelting and Refining Co., at Morse, continued its operations until October. The Villa government threatened confiscation unless the smeltery was put in operation, and actually did attempt to start the furnaces, but gave it up as a bad job. The Mina Vieja, Velardeña and Sin Nombre mines at Santa Eulalia, belonging to the same company, were in operation until October. The Potosí mine at Santa Eulalia was shipping 300 to 400 tons of ore per day to the smeltery at Morse until October. The Buena Tierra mine belonging to the Exploration Co. of England & Mexico, Reina de Plata, and San Toy properties had almost a normal force at work until October. The Cigarrero mine near Baca was closed most of the year.

The Cusi Mining Co., in the Juarez district of Chihuahua, operating the Promontorio mine at Cusihuiriachic, produced rich ore until October. The Guadalupe y Calvo property was too far removed from communication and did no work of consequence. The Concheno, belonging to the Corrigan-McKinney interests, did but little work. The Sierra Mining Co. at Jesus Maria was forced to suspend operation.

The Year in Coahuila, Guanajuato and Guerrero

In Coahuila the Reforma mine near Cuatro Cienegas shipped some ore to the smeltery. Construction work was continued and some shipments made of zinc ore from the Cabrilla and Paloma mines, owned by the Cia. Peñoles.

y Anexas, near Cabrillas. Small shipments were made by the Vulcan mine at Sierra Mojada. The Veta Rica mine, belonging to the Mexican Metallurgical Co., also made some shipments of lead ore. The Torreon smeltery operated only part of the year.

In Durango the Bacis Co. did a little work, while the Candelaria, at San Dimas, has been shipping about 100 tons per day of mine and dump ore. The Tominil mine has been closed since 1912 with the exception of a small amount of development which is being continued. The Peñoles, at Ojuela, was operating its mine and smeltery until October, when all foreigners left. The Asarco smeltery was in operation during part of the year, as well as the mines of the American Smelters Securities Co. at Velardeña.

In the Guanajuato camp some of the properties which were operating until the Obregon forces reached the state were the Amalgamated Gold Mines, the Guanajuato Consolidated, the Guanajuato Reduction and Mines Co., the Guanajuato Development Co. and the Proprietary Mines Co. In the Pozos district there was very little activity, due partly to railroads between San Luis Potosí and Queretaro being out of commission most of the year.

Very little work was done in Guerrero, owing both to political disturbances and lack of transportation. The principal properties are the Chontalpan, at Tetepac in the Zacualpan district, and the Reforma Mining and Milling Co., at Campo Morado. The latter property has been under option to several large operators, but the options have invariably been thrown up because of the high price at which the property is held.

In Hidalgo the only mines of consequence that were in operation were those of the Pachuca district. Among the most important are the Blaisdell, La Blanca, Real del Monte, San Francisco, San Rafael, Santa Gertrudis and Union. Most of these operated on a reduced scale, being hampered by political disturbances and inability to obtain supplies. In Jalisco the Magistral mines found difficulty in concentrating the ore. The Amparo, the Favor and Mololoa have been badly handicapped by revolutionary activities, as have also all the other mines. The Bolanos finished a wagon road 100 km. long connecting Bolano with Colotlan, and a cyanide plant is planned as soon as political disturbances cease. The Cinco Minas cyanide mill has been finished and was in operation part of the year. Political disturbances led to the murder of two foreigners by Mexicans in the Hostotipaquillo district.

El Oro Companies Idle

In the State of Mexico the mining companies in El Oro district were subject to raids and consequent inability to continue operations. Blanco and others entered the camp in the early part of the year and looted the houses of many of the foreigners and killed some of the native employees. El Oro Mining and Railway Co. continued pumping as well as some development work, but did not operate the mill. Esperanza and Mexico Mines of El Oro were also unable to continue operations on any reasonable scale.

In Michoacan the Angangueo properties, leased to the American Smelting and Refining Co., have continued operations on a reduced scale throughout most of the year. In Nuevo Leon the Minas Viejas, near Villaldama, affiliated with the American Metal Co., were in operation, as well as the zinc-calcining plant belonging to the same company near Villaldama, producing zinc ore. The lead property of the American Smelting and Refining Co. at Monterey was in operation part of the year, closing in August.

In Oaxaca very little work has been done. The Ocotes property, owned by the Towne interests, is the principal mine and is said to have a million tons of ore blocked out. The treatment problem has not been altogether solved. The principal mines of the Ocotlan district are the Benjamin, Esquadra and San Juan mines. Considerable litigation has interfered with the operations of the San Juan mine, now owned by Judge L. R. Wilfley. In Puebla the Tezuitlan mines and smelteries, owned by interests closely allied with the Cia. Metalurgica Mexicana, have remained closed during the year. The Ajuchitlan Mining and Milling Co., of Queretaro, near Bernal Station, was unable to operate to advantage owing to inability to obtain cyanide and other supplies. El Doctor Mine, 50 mi. from Bernal, remained closed during the year.

In the Catorce district of San Luis Potosí the principal mines are the Candelaria, Catorce, Concepcion, Dolores, Trompeta and several others. In the vicinity of Matehuala are the mines of the American Smelters Securities Co., the Santa Maria de la Paz and others. The smeltery remained closed during the entire year, thereby making it almost impossible for the properties of the district to operate profitably. The smeltery in San Luis Potosí, belonging to the Cia. Metalurgica Mexicana, also remained closed. The same is true of the mines at San Pedro. In the Venado district most of the mines are near Charcas, and while some of them have been operating on a small scale, the work done is not worthy of serious mention. Nothing other than general repairs was done at the Tiro General, belonging to the American Smelting and Refining Co.

In the principal districts of Sinaloa practically nothing was done. The Panuco, in the Concordia district, was confiscated and worked by Carranza sympathizers. At Copala the property owned by Charles Butters & Co. has proved a disappointment, and no work was done. The state in general was practically dead during the year.

Quiet in Sonora and Zacatecas

In the Alamos District of Sonora, La Dura mine, belonging to the Mines Company of America, was closed during the entire year, as were also the Promontorio and the Zambona. At Arizpe the Calumet & Sonora, Cananea Consolidated, Pedrazzini and Transvaal, are among the principal properties. The Greene Consolidated operated intermittently, being closed at times because of interruption of railway service between Cananea and Naco. In the Guaymas district the mines were closed during the entire year. At Minas Prietas the Creston Colorada, belonging to the Mines Co. of America, continued work for a part of the year. The dumps and mine are nearly exhausted. No work has been done at San Antonio de la Huerta, this mine being in the heart of the Yaqui country. In the Moctezuma district the Cinco de Mayo mine was reported seized and being worked by the so-called authorities. The Minneapolis Copper Co. attempted to work, but was interrupted by political disturbances. The Pilares de Nacozari mine, belonging to the Moctezuma Copper Co., was in operation at such times as it

was possible to handle supplies and concentrates over the railroad to Douglas. Work was continued at the Tigre mine during part of the year, but later the foreign employees were all ordered out of the country. In Sahuaripa very little work was attempted at the Bufa or Cieneguita properties. At Mina Mexico, work was continued for a time. A few properties in the Ures district attempted to do some work, but not much was accomplished.

Practically no work was done during the year in the State of Tamaulipas. There were several zinc mines in the Santa Engracia district, among which the Dulces Nombres mine may be mentioned as the one at which some work was done during the year.

In the Fresnillo district of Zacatecas no work of consequence was done by the Towne interests. In the Mazapil district mining was under a cloud and could not be prosecuted. For a year or more the property of the Mazapil Copper Co. was used as a rendezvous for the forces of Eulalio Gutierrez, and the mechanics were forced to make bombs which were used to destroy trains on the National Line. Practically everything that was portable, including the hoisting engine, was removed from the Orozco properties. At Pinos nothing of consequence was done at the Candelaria or Cinco Estrellas properties. In the Zacatecas district several large mines are situated, but practically no work was done during the entire year. At La Fé watchmen were maintained and pumping was continued to keep the mine clear of water. At El Bote the same conditions existed, but no ore extraction was accomplished.

South America in 1915

South American mining activity in 1915 was mainly confined to those operations which were already under way or for which capital had been previously arranged. A noteworthy exception to this was the entrance of the Anaconda Copper Mining Co. interests in Chilean mining through acquiring control of the Andes Exploration Co. The important dredging interests in Colombia each completed a new dredge in 1915, and the Chile Exploration Co. brought into bearing its great enterprise at Chuquicamata. The high price of the metals stimulated activity in certain lines, but few new enterprises were able to find the capital necessary for starting development campaigns.

Chile

The bringing to fruition of the great enterprise of the Chile Exploration Co., the metallurgical improvements at Braden Copper Co. and the activities of the Anaconda Copper Mining Co. through the Andes Exploration Co., together with other important matters relating to the mining activities of Chile in 1915, are covered elsewhere in this issue in the section on copper. Besides these operations of the first magnitude, many older companies, such as the Cia. de Minas de Cobre de Gatico, Central Chili Copper Co., Lota i Coronel, Calama, Soc. des Mines de Cuivre de Naltagua, Soc. des Mines et Fonderies de Chañaral and Soc. des Mines de Cuivre de Catémou, operated without interruption notwithstanding the low prices following the outbreak of the European War. The Catémou company increased its smelting capacity and had plans made for a new concentrator. Gatico is erecting a larger water-jacket furnace that will blow in about Feb. 1, 1916, when the rate of production will be about 400 tons of converter bars per month. The Carrizal company, in the district of Vallenar, produced about 100 tons of copper monthly in the form of matte. The Guayacan, in the Province of Coquimbo, installed a modern blast furnace, but closed down owing to financial difficulties. The smelting plant at Incienso was operated and the Cia. Industrial de Atacama ran its Caldera plant, shipping the matte to Lota, where it was converted. Several companies shipped ore and concentrates from the Collahuasi district in the extreme north, the Poderosa sending out from 300 to 500 tons monthly of ore carrying around 20% copper.

Concessions were asked for two smelting plants to be erected at Arica to smelt Bolivian tin and copper concentrates. An export tax on copper and other metalliferous products is under consideration by the Chilean congress. Las Vacas gold mine, in the Province of Aconcagua, operated until autumn, producing 85 kg. of gold up to September; a reorganization is now in progress.

At Tofó, the Bethlehem-Chile Iron Mines Co. continued the development of its great iron property and sent out 160,000 tons of ore, shipments having been only slightly curtailed by the Panama Canal closure. German and Dutch interests acquired the Algarobo iron deposits in the Vallenar district.

The Pintados potash deposits, about 45 mi. southeast of Iquique, were examined for North American interests. The nitrate industry experienced a sharp recovery in 1915; the du Pont interests purchased additional nitrate lands, *oficinas* and steamers to ply between the West Coast and the United States, via the Panama Canal. Coal production surpassed that of any previous year.

Peru and Ecuador

The most important event of 1915 in Peruvian mining was the passage of an export tax on mineral products, which had enjoyed exemption from special taxation for nearly two decades; details of the new tariff were given in the *Journal* of Dec. 18, 1915. The leading mining operations in Peru, as heretofore, were those conducted by the Cerro de Pasco Mining Co. and the Backus & Johnston Co. Stimulated by the high price of copper, both of these companies increased their outputs, reaping the benefit of previous campaigns of improvement in facilities. At the end of 1915 the Cerro de Pasco company was producing at the rate of 6,000,000 lb. per month. An interesting occurrence in this connection was the incorporation of the Cerro de Pasco Copper Corporation to take over the Cerro de Pasco interests. Its capitalization is now represented by $10,000,000 of convertible bonds and 1,000,000 shares of no-par value. Since the bonds are convertible at $30, it would indicate a nominal capitalization of the Cerro de Pasco properties at $30,000,000. The copper deposits at Magistral and Quiruvilca were operated in a small way, but only the high-grade ore could be handled. The Soc. Minera Quiruvilca is erecting a small smelting plant, and roads are to be built for motor-truck transport.

The wolfram mines in the Tamboras, Huaura and Huallapon were actively operated. In the old Pataz gold

district, worked since colonial times, modern milling machinery was installed, the mill at the Gigante mine having been remodeled for the continuous-decantation process. In the south, the Inca Mining and Development Co. continued its operation near Carabaya, in the Department of Puno. Cotobambas Auraria, in Apurimac, erected a 50-ton plant designed by Ferdinand McCann.

Production from placers was small. The most striking event of the year in placer mining was the pricking of the Marañon River Placers bubble by the United States postal authorities. Exploration for American interests in the southern part of the republic did not result in the acquisition of properties.

Coal mining, as heretofore, was done principally by the Cerro de Pasco company. Operations at the borax properties near Arequipa were held in abeyance by the proposed export tax, which was finally fixed at two shillings per ton. The oil regions in the north were active, especially in the latter part of the year, when much new work was undertaken. Lobitos produced about 88,000 tons, and Lagunitas at the end of 1915 was shipping about 5,000 tons monthly. Exploration by the Cardalitos company was resumed late in the year.

In Ecuador gold production in 1915 is estimated at $600,000, about $500,000 of which was from the district of Zaruma, Province of El Oro, where the South American Development Co. continued active exploration, finished the construction of the new water-power plant and completed plans for a new metallurgical plant embodying the Dorr counter-current decantation method.

Bolivia and Colombia

In Bolivia the copper companies operating in the vicinity of Corocoro profited by the high price for this metal, and a number of small mines besides those of the two principal companies—Corocoro United Copper Mines, Ltd., and Cia. Corocoro de Bolivia—were worked. The former company petitioned the Chilean government for a concession of ground at Arica, Chile, on which to erect a smelting plant.

Tin operators were not so fortunate in the matter of price and markets as were the copper mines. Work during the first part of the year was largely restricted to development, with a gradual resumption of operations. By October Aramayo Francke Mines, Ltd., reached normal production, especially in its tin and silver output. The new mill of the Porco Tin Mines, Ltd., at Agua Castilla, proved of greater capacity than calculated; ball mills were installed instead of stamps. The two largest tin producers, as usual, were Simon I. Patiño and the Llallagua company. The Llallagua company's interests planned to erect a tin-smelting works at Arica, Chile, the Cia. Chilena de Fundicion de Estaño having been incorporated for this purpose. Two proposals were made to the Bolivian governement for the establishment of electric tin-smelting plants within the country. No action was taken on these proposals, so far as is known.

Wolfram and antimony mines increased their outputs, but silver and zinc production declined, largely owing to reduced operations of the Huanchaca Co. at its Pulacayo mine. The Olla de Oro gold mine worked steadily and increased its milling capacity to 100 tons daily.

Although the lode mines made important improvements in 1915, the predominant feature of Colombian mining continues to be the new dredging operations. The Pato dredge on the upper Nechí, according to cable advices, had averaged over 33c. up to December. Estimating December, the yardage handled would approximate 1,450,000 yd. for a return of over $450,000. During the first half of 1915 the dredge returns were over 50c. per cu.yd., but the average for the last six months was around 20c. The dredge worked outside the tested area for part of this period. The Nechí dredge was launched in September, but had to dig in low-grade gravel for about two months before getting into the rich ground across the river. An interruption to operations occurred in November, when the bucket line broke. The Pochet dredge on the Nechí was reported purchased by C. J. London and associates.

The Anglo-Colombian Development Co. launched its dredge on July 20, in the Condoto River, in the western part of the country. While no figures have been given out, the company announced that the yield justified the results reported during the period of prospecting. The gravel contains both gold and platinum. A power survey was being made, and additional dredges are under contemplation. Further prospecting was done by the General Development Co. in this field, and British interests were also prospecting placer areas in the West Coast country. Up to 1915 platinum was recovered only by native methods—that is, chiefly with *bateas* and in small opencuts—but with the installation of dredges in this field the platinum output will probably be increased.

Among the lode mines the Frontino & Bolivia Gold Mining Co., Ltd., continued its campaign of improvements, erecting a 50-ton counter-current decantation plant and an auxiliary pan-amalgamation mill for handling concentrates. The company placed a new 1,050-lb. stamp mill in operation in September, and the old, or upper, mill of thirty 450-lb. stamps will be remodeled gradually. The Salada mine was closed, but the company acquired an interest in the Cogote and Marmajito mines. The Tolima Mining Co., which operates the Frias and neighboring silver mines, produced 464,234 oz. of fine silver in its fiscal year, ended June 30, 1915. However, owing to the commandeering of its smelting works, the company was compelled to cease shipping "export mineral" and confined its work in the latter part of the year to development. El Recreo, in Ibagué district, and other lode mines for the most part operated steadily throughout the year, but many developing enterprises were stopped for lack of capital.

The largest hydraulicking operation was that of McGuire Bros., who continued to operate La Clara on the Porce River, opened the Miraflores mine across the river, and mined part of the old bed of the Porce, which has been diverted. The richest part of the river bed was not reached in 1915. Vallecitos' hydraulic operations at Anorí were limited by dryness of the season, and Viborita at Amalfi did prospecting only. The famous emerald mines near Bogatá have not been worked for several years.

Venezuela and the Guianas

In 1915 the South American Copper Syndicate resumed the operation of its Aroa smelting plant at full capacity, the smelting staff having been dismissed at the beginning of the European War. In the Aroa district the Cumaragua company continued developments, as did also the Gathmann interests. El Amparo Mine, Ltd., a British corporation, worked its rich gold mine in the Yuruari section of Bolivar. The Cia. Anonima Minera lo Increible

continued throughout the year, but its reserves were small. The Barber asphalt interests operated the Bermudez Lake asphalt deposits, as usual, and drilled one oil well in the sands near the asphalt lake. The Venezuelan Oil Concessions, Ltd., which the Shell Group has absorbed, put down a fourth well on the Santa Barbara anticline in the Lake Maracaibo region.

In the Guianas most of the mining activity continued to be restricted to placer mining. This work comprised both dredging and sluicing operations. The Cie. des Mines d'Or de la Guyane Hollandaise, which had such a successful year in 1914 despite the raid of a marauding band, did not do so well in the early months of 1915. The recovery for 1914 was 352,008 grams, valued at 1,131,614 francs. There are several dredging companies representing French and Belgian capital in this region. The diamond production was not officially reported, but was undoubtedly below normal.

Brazil and Other East Coast Republics

A feature of Brazilian mining was the increased output of manganese ore due to the war in Europe closing other sources of supply. The most important company, as heretofore, was the Morro da Mina, which exports about two-thirds of the manganese ore shipped from Brazil. The war also affected favorably the single operating coal mine in the southern part of Brazil. Shipments of zirconia and monazite sand to Germany being impracticable, there was a great falling off in the production of these ores.

The two important gold mines of Brazil enjoyed a successful year, both St. John del Rey and Ouro Preto having experienced a slight increase in the gold content of their ore. The St. John del Rey is sinking its G shaft to the level of horizon 20, a depth of over 1.1 mi. from the surface; adits were being driven from the shaft to intercept the lode at horizons 19 and 20. The yield from 199,234 tons in 1914-15 amounted to £455,927, which was the largest since the company began its mining operations. The Ouro Preto Gold Mines of Brazil profited both from the more plentiful labor supply and from the slightly increased yield of its ore. About 7,300 tons was milled per month for a return of about £10,000.

The only feature of special interest in diamond mining was the announcement by the late director of the Geological Service, Orville A. Derby, that a member of his staff had found pipes of kimberlite in the region west of the upper São Francisco, thus confirming the opinion long held by the Geological Service.

In the southern East Coast republics mining was not active in 1915. Practically no new operations of importance were undertaken. Paraguay and Uruguay were comparatively quiet, owing to the general business depression. The talc mine at Conchillas in the Department of Colonia, Uruguay, was actively worked, and the Instituto de Geologia y Perforaciones made borings at this property to determine the extent of the formation. Working of the large manganiferous iron deposits in the Department of Rivera was under consideration, but did not reach the point of actual exploitation. Generally speaking, the mining industry advanced only slightly in 1915, owing to the prevailing financial stringency. This was in part counterbalanced by the war-stimulated activity in copper, wolfram and manganese.

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Central America in 1915

Central American mining properties that had reached the productive stage were operated about as usual in 1915. Few new undertakings were begun, and though options were taken on several properties of importance, the negotiations did not bear fruit, as the properties were held at too high a price.

Costa Rica and Honduras

The principal operations in Costa Rica were those of Abangarez Goldfields, Aguacate Mines, and La Union mine of the Costa Rica Union Mining Co. at Miramar. Abangarez, upon resumption, was operated on royalty by John N. Popham, full operation not being reached until late in 1915. Aguacate Mines worked throughout the year and continued driving its 10th-level adit. Montezuma Mines of Costa Rica is understood to have worked steadily. In Honduras the New York & Honduras Rosario Mining Co. operated its mill and mine at slightly increased capacity, milling 118,000 tons for a yield of 1,800,000 oz. of silver and 15,300 oz. of gold. The company did considerable prospecting in the surrounding region, but did not begin production at any new properties. On Nov. 17, 1915, the 35th anniversary of the company's corporate existence and uninterrupted operation was celebrated. The Socorro Gold and Silver Mine, Ltd., is understood to have operated its property at Valle de Angeles. No new operations of importance were undertaken.

The most interesting feature of mining in Guatemala was the discovery by the Guatemala Mining and Development Co. of a new body of superior white marble only eight miles from the railroad at Zacapa. Preparations are being made for extension of the railroad and active exploitation. The Alotopeque district was comparatively inactive, but preparations were made for further development in 1916. The Potts & Knight placers at Las Quebradas were operated as usual.

Salvador and Nicaragua

The Butters Salvador Mines, Ltd., in the Republic of Salvador operated continuously in 1915, crushing about 40,000 tons for a yield of about $600,000. The Butters Divisadero Co.'s operations were interrupted in the summer by a fire which destroyed some surface buildings and burned the timber of the shaft. To extinguish the fire the mine was flooded, resulting in several months' interruption of crushing. An 11,800-ft. aërial tramway was completed to a neighboring *antigua,* the ore of which has been purchased. Two Bolinder crude-oil engines were shipped from Sweden to supplant the steam engines now used at the Divisadero. The Comacaran Gold Mining Co., at Mineral Hormiguero, increased its milling equipment, treating at the end of 1915 about 6,000 tons monthly of $8 to $12 ore. The company operates the Gallardo, Hormiguero and Guadalupe mines.

In Nicaragua the Eden Mining Co., a subsidiary of the Tonopah Mining Co. of Philadelphia, continued its campaign of construction. The Leonesa mine at Matagalpa and the Babilonia at La Libertad both assumed a better position in 1915, making profits and repaying some of

the advances made by the Lake View & Oroya Exploration Ltd., of London, which controls these mines. Cristino Hansen operated a 3½-ft. Huntington mill on ore from the Guapinol and Orosi group of mines. It is understood that the La Luz & Los Angeles Mining Co. continued its operations in the Prinzapolka district. At Wawa, W. B. Milliken was erecting a cyanide mill for the Linda Ventura mine. Options were taken on several Nicaraguan mines by Tonopah and Canadian interests, but were not exercised, owing, it is understood, to insufficient development. In Panama, the old Darien Gold Mining Co. was reported sold to Thomas Arias and associates, who intended to exploit the mine. Some manganese explorations were in progress on the Atlantic coast.

Mining in Ontario in 1915

By Thomas W. Gibson*

Notwithstanding the fact that gold had been discovered in many and widely separated parts of Ontario, production was insignificant until 1912, when the mines at Porcupine began to yield. In that year the output was a little over $2,000,000. In 1915 it rose to about $8,000,000, which was an increase over 1914 of nearly $2,500,000. Of the total yield, all but $750,000 came from the mines of the Porcupine camp. Chief among these is the Hollinger, whose mill was treating 7,034 tons per week in November as against 5,706 tons in January, and making a gross profit of $46,192 per week as compared with $37,746. The average value of the ore varies but little from month to month. It began in January at $11.10 per ton and in November was $10.34. The total output for the year was about $3,000,000.

Hollinger the Greatest Gold Mine

The Hollinger, which is paying 4% dividend every four weeks, or 52% per annum on its capitalization of $3,000,000, has a claim to be ranked among the great gold mines of the world. Its veins are numerous and persistent in depth, and some of them are large. A number of new and valuable veins have recently been found in underground exploration. A six-compartment central shaft is being steadily pushed down, and it is intended to operate the adjoining Acme claims, controlled by the same interests, in conjunction with the Hollinger. The Acme ore is treated in the Hollinger mill, but the returns are kept separate. The yield from the Acme for the 12 months was over $900,000.

The Dome mine is next in importance at Porcupine. Opened on a mass of quartz that showed remarkable value in spots, the Dome speedily took on the character of a low-grade mine, the average value per ton treated in 1914 being $4.25. Richer ore, resembling that of the original Dome, struck on the fourth and fifth levels, has materially improved the Dome's prospects and raised the average yield to $5.50 per ton. The mill is being enlarged and is expected to be in shape next March to treat about 55,000 tons of ore per month. The production for 1915 was about $1,325,000.

McIntyre-Porcupine has recently taken over the Jupiter claims, and under the new management is doing well. The yield for the year is about $750,000. Other Porcupine mines and their production for 1915 are: Porcupine-Crown, $600,000; Porcupine-Vipond, $265,000; and Dome Lake, $105,000. Schumacher, the latest addition to the list, began production in November.

At Kirkland Lake the Tough-Oakes mill went into operation early in the year and has run steadily ever since. The yield was about $450,000, the ore averaging $19 per ton. The Canadian Exploration Co., at Long Lake, won about $260,000. In Munro Township, quartz of phenomenal value was found in the Dobie-Leyson claim, now known as the Crœsus mine. From 800 lb. of rock $40,000 in gold was recovered by hand, and in a shaft 125 ft. deep, with a little drifting and crosscutting, it is reported that a million dollars' worth of gold has been put into sight.

The year was more than ordinarily prolific in promising discoveries. In Boston Township J. K. Papassimakes is developing a claim which shows in places a free distribution of fine gold in dark greenish quartz, and in Pacaud, the next township to the south, Miller and Connell have acquired the McDonough claim, one of the best-looking finds of the year. This is a quartz vein a foot wide and about 2,000 ft. long, showing free gold wherever uncovered. At Kowkash, 300 mi. west of Cochrane, on the National Transcontinental Ry., a spectacular find of gold in quartz was made in August by E. King Dodds, but on sinking, the values disappeared. South of Dryden, on the Canadian Pacific, near Lake Wabigoon, a narrow and irregular vein showing abundance of free gold was located by E. G. Rognon. These veins no doubt will all be opened up in the near future. Meantime the year closed with a decidedly optimistic feeling so far as gold mining is concerned.

Taken together, the value of the gold and silver obtained in Ontario in 1915 exceeded that obtained in 1914, but while the production of gold is going up, that of silver is going down. The famous mines of Cobalt have passed their zenith, and their yield is decreasing. The output in 1915 had a value of about $10,750,000—a little over two million dollars less than in 1914. Production was stimulated by the sudden and decided rise in the price of silver in November. Much the larger production of the silver output of Ontario is now refined in the province, partly at the mines themselves and partly by the smelters at Thorold and Deloro. Byproducts of the Cobalt ores, particularly cobalt oxide and nickel oxide, had a poor year, the continental markets in Europe being cut off by the war. In consequence, stocks of these substances are accumulating at the refineries. The latter are now beginning to produce metallic nickel and cobalt.

Nickel, Copper and Iron Production

The production of nickel was greatly stimulated by the demand for war purposes, the output being about 32,000 tons, much the largest for any single year. The production is confined to the Canadian Copper Co., Copper Cliff, and the Mond Nickel Co., Coniston. The ores

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smelted by the former come mainly from the Creighton mine, which carries about 5% nickel and 2% copper; those treated by the latter were raised from a number of openings, including the Alexo, a deposit on the Porcupine branch of the Temiskaming & Northern Ontario Ry. About 75% of the yield is to be credited to the Canadian Copper Co. and about 25% to the Mond company, but since the opening of its new smeltery at Coniston the output of the latter is much increased. Both companies produce a converter product containing 75 or 80% copper and nickel. That of the Copper company carries about 50% of nickel and 25% of copper; that of the Mond company, about 40% each of nickel and copper. A third concern, called the British America Nickel Corporation, has acquired extensive deposits of nickel-copper ore, and proposes to enter the field, but the financial disturbances due to the war have interfered with its plans.

Of copper the yield was about 18,850 tons. Practically the entire output was from the nickel-copper ores of Sudbury, the principal exception being the ore raised from the old Bruce mines by the Mond Nickel Co. and used to supply silica for mixtures in that company's smelteries.

The shipments of iron ore showed a decided increase over those of 1914, the producing properties being the Magpie, Helen and Moose Mountain. On the other hand, the quantity of pig iron turned out by the blast furnaces of the province fell off materially. Most of the iron ore charged in these furnaces is imported from the United States.

The production of building materials and clay goods was less than usual, owing to the stoppage of building operations consequent upon the war. Petroleum continues to be pumped in the Lambton field, but in diminishing quantities, the yield in 1915 being not over 7,000,000 gallons. Natural gas, on the other hand, has been obtained in much larger volume during recent years than formerly, and valued at a low figure at the wells, the production in 1915 was worth about $2,300,000. The mining of iron pyrites is yearly increasing, and many other substances such as graphite, mica, corundum, feldspar, gypsum, salt, quartz, talc, arsenic, etc., furnish employment to a considerable extent for capital and labor.

Transvaal Mining in 1915

By H. F. Marriott*

The gold-mining activities of the Transvaal maintained a steady course throughout the year. The strength and solidarity displayed by this great industry have never made so great an impression as recently in the face of both war and rebellion. The need of keeping the production of gold at the highest possible level was recognized by all, and to this end the captains of the industry, assisted by a good supply of labor, devoted themselves. Tables 1, 2 and 3 show respectively the increased yield, the enlarged milling capacity and the improved labor position attained during the year. On Sept. 30 there were 53 producing companies on the Rand. Working costs were 6d. a ton higher, chiefly because of the increased price of materials and stores.

TABLE 1. TRANSVAAL GOLD PRODUCTION

	Witwatersrand District				
Year	Tons Milled	Value	Value per Ton Milled, Shillings	Outside Mines, Value	Total Value for Transvaal
1884-89	1,000,000	£2,440,000	48.8	£238,231	£2,678,231
1890	730,000	1,735,491	47.4	134,154	1,869,645
1891	1,154,144	2,556,328	44.2	367,977	2,924,305
1892	1,979,354	4,297,610	43.3	243,461	4,541,071
1893	2,203,704	5,187,206	47.0	293,292	5,480,498
1894	2,830,885	6,963,100	49.2	704,052	7,667,152
1895	3,456,575	7,840,770	45.2	728,776	8,569,555
1896	4,011,697	7,864,341	39.2	739,480	8,603,821
1897	5,325,355	10,583,616	39.7	1,070,109	11,653,725
1898	7,331,446	15,141,376	41.3	1,099,254	16,240,630
1899	6,872,750	15,067,473	48.8	661,220	15,728,693
1900	459,018	1,510,131	65.8	.....	1,510,131
1901	412,006	1,014,687	49.2	81,364	1,096,151
1902	3,416,813	7,179,074	42.0	74,591	7,253,665
1903	6,105,016	12,146,307	39.8	442,941	12,589,248
1904	8,058,295	15,539,219	38.5	515,590	16,054,809
1905	11,160,422	19,991,658	35.8	810,416	20,802,074
1906	13,571,554	23,615,400	34.8	964,587	24,579,987
1907	15,523,229	26,421,837	34.0	981,901	27,403,738
1908	18,196,589	28,810,393	31.6	1,147,217	29,957,610
1909	20,543,759	29,900,359	29.1	1,025,429	30,925,788
1910	21,432,541	30,703,912	28.5	1,297,823	32,001,735
1911	23,888,258	33,543,479	28.1	1,498,006	35,041,485
1912	25,486,361	37,182,796	29.2	1,574,765	38,757,560
1913	25,628,432	35,812,605	27.8	1,545,435	37,358,040
1914	25,701,954	34,124,434	26.5	1,463,641	35,588,075
1915 (est.)	27,949,466	36,782,131	26.3	1,356,444	38,138,575

Operations were hindered in several cases by abnormal natural occurrences. Early in the year excessive rainfall caused the flooding of several workings and brought about delays more or less serious. One instance was at the Bantjes Consolidated Mines where, in December, 1914, the central incline shaft collapsed through the saturation of the decomposed dike above the sandstone forming the roof of the shaft. This matter is referred to again herein.

Another disturbing agent was the recurrence of earth tremors along the reef. This affected portions of the workings of the Ferreira Deep and Village Main Reef mines, in which heavy falls of rock took place, temporarily interfering with hoisting. Owing to the continuance of this phenomenon, an Earth Tremors Commission was appointed, which consisted of the government mining engineer, the government astronomer and a consulting engineer from one of the mining groups. The commission held its first meeting June 29, but has not yet published its findings.

Two mines in the far western Rand went into liquidation—the French Rand Gold Mining Co., Ltd., and the Lancaster West Gold Mining Co., Ltd. The New Rietfontein, on the Du Preez reef, north of the Main Reef Series, had to be closed owing to lack of further prospective profit. On the other hand, arrangements were made to reopen the eastern portion of the Jupiter mine, and milling, which had been discontinued in 1913, was resumed Sept. 1. The New Goch and Randfontein Central reappeared in the list of dividend payers.

Another Important Amalgamation

After negotiations extending over several years, a scheme was finally agreed to in December for the amalgamation of the Robinson Deep Gold Mining Co., Ltd., Booysens Estate, Ltd., and South Deeps, Ltd. It was decided to form a new company, to be called Robinson Deep, Ltd., with a capital of 500,000 cumulative preference shares of 1s. each ("A" shares) and 900,000 shares of £1 each ("B" shares). The result of the amalgamation

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to the producing company, it was estimated, would be to give its shareholders in the new company a guaranteed income from dividends during 25½ years, as against dividends during a few years only if the old company retained its corporate existence.

TABLE 2. STAMPS AND TUBE MILLS

	Stamps at Work	Tube Mills at Work	Duty per Stamp per Day
1909, December	9,250	148	6.8
1910, December	9,150	184	7.2
1911, December	9,565	244	7.9
1912, December	9,440	277	8.4
1913, December	9,170	278	8.7
1914, December	9,291	294	9.1
1915, September	9,515	315	9.6

Considerable attention was again devoted to the eastern Rand. Nine companies were producing in 1915, eight of which paid dividends. The ore crushed was at the rate of 4,730,000 tons a year. Preparations are being made to raise this output during 1916 to 6,750,000 tons a year. Development generally was good, and confidence in the district has been still further strengthened.

The Springs Mines, Ltd., drew nearer to the producing stage and commenced the erection of a plant with a capacity of 360,000 tons a year. Development at this mine to the end of September disclosed ore of which 54% was regarded as profitable.

Several extensions of plant were considered. Orders were placed by the New Modderfontein Gold Mining Co. for an additional reduction plant of 40,000 tons per month, which, with the existing plant, will enable the company to treat about 1,100,000 tons a year. The Government Gold Mining Areas (Modderfontein) decided to double its plant by the addition of another 100 stamps. The Geduld Proprietary Mines decided also to extend its plant so as to increase its capacity from 24,000 to 40,000 tons a month. This company paid its first dividend in February, the rate being 5%. The mill of the Modderfontein Deep Levels made its first full month's run in January, when it crushed 25,750 tons of an average gold content of 37.8s. Toward the end of the year more than 34,000 tons of ore a month were being treated at a working profit of about 20s. a ton. An increase of plant by the addition of 10 stamps was decided upon, the cost to be met out of profits. A dividend of 10% was paid in respect of the half-year to June 30, this being the company's first distribution. Very good developments were recorded at the Van Ryn Deep. At this mine the gold left in the slimes residue was reduced to less than 8d. a ton.

Gold Mining and the War Expenses

The arrangements made at the beginning of the war for realizing the gold produced and obtaining supplies continued in force during the year under review. To assist in meeting the expenses of the war and the rebellion, the union government imposed extra taxation on "the profits of mining for gold," in the form of a special levy of £500,000, to be paid during the financial year to end Mar. 31, 1916. This sum is approximately 5% of the profits earned, as calculated for the purpose of profits tax, and a first instalment of 2½% was due Dec. 31, 1915.

The Vaal River water-supply scheme sanctioned by the union government during the previous year could not be carried out on account of the difficulties in the way of raising the necessary loan. There is, however, no immediate cause for anxiety in regard to water-supply.

A revival of interest in mining in the Murchison Range district was brought about by the opening of the Zoekmakaar-Komati Poort railway, which linked together the Delagoa Bay line and the Messina-Pietersburg extension. Lack of enterprise in the district had been previously caused not only by the difficulties of transport, but also by the refractory nature of the gold ores due to the presence of antimony. With regard to the latter, a process for dealing cheaply and successfully with the ores was brought forward, and a treatment plant was installed at the United Jack mine and started in October. Revenue from both the gold and antimony contents of the ore was expected.

TABLE 3. LABOR EMPLOYED IN TRANSVAAL GOLD MINES

	Whites	Natives	Native Death Rate per 1,000
1910	25,376	191,784	35.72
1911	25,108	194,286	31.01
1912	24,334	206,121	28.83
1913	22,797	162,181	26.61
1914	21,834	177,291	20.44
Jan., 1915	21,765	181,194	
Mar	22,179	197,543	
May	22,415	200,162	12 mo. ending
July	22,765	201,465	Sept., 1915,
Sept	23,516	215,332	19.76

The most important item with regard to labor was the abolition of the flat-contract system by companies affiliated to the Transvaal Chamber of Mines. This took place as from June 1, existing contracts remaining in force until their expiration. Under this system a miner was paid a fixed sum per square fathom broken, irrespective of subsequent variation in the nature of ground during the period of his contract, and out of this sum he had to provide explosives and native labor. His remuneration, therefore, was liable to great variation as his work progressed, and to the system was attributed the migratory character of underground labor. No particular method of payment was substituted in place of this system, it being left to those concerned to arrange matters so that, in accordance with the wishes of the government, all mine employees should obtain a certain definite daily wage. The abolition of the flat-contract system was among the recommendations made by the Economic Commission and the Dominions Royal Commission.

A joint committee of the Transvaal Chamber of Mines and of mine employees was formed to consider the cost of living and a demand of mine workers for an increase of wages. A memorandum of agreement was adopted on July 23 and accepted by the mining groups and the workers' unions. The terms of the agreement related chiefly to wages, hours and overtime.

Social and Technical Improvements

The aim of "safety first" was kept before mine workers by the monthly circulation, gratis, of a magazine called *The Reef*, published under the auspices of the "Safety-First" committee of the Rand Mutual Assurance Co. The first number appeared in July. Among the contributors were the minister of mines and the government mining engineer.

With a view to increasing the knowledge and efficiency of underground employees the Transvaal Chamber of Mines distributed a pamphlet by E. M. Weston entitled "Practical Mining on the Rand." Intended for the use of shiftbosses and miners, it gave hints and directions in regard to the types of rock drills in use on the Rand and the handling of them underground, the nature and use of explosives, development, stoping and hammer work.

The progress in technical matters was reflected in a number of excellent papers read before various societies. Much valuable and interesting information was contained

in a paper by J. H. Rider, "The Power Supply of the Central Mining-Rand Mines Group," read before the Institution of Electrical Engineers (Vol. 53, Nos. 247, 248 and 250, 1915). From this it appears that the annual consumption of the group is at the rate of about 310,000,000 electrical units and 103,000,000 air units. The most important service for which electricity is used is that of winding. Useful particulars were given of the method of metering the supplies.

The latest methods in metallurgy were described by F. L. Bosqui in his paper, "Metallurgical Practice in the Witwatersrand District, South Africa," published in the *Bulletin* of the American Institute of Mining Engineers, May, 1915.

Developments in the eastern Rand received their share of attention. The geology of the district was dealt with by E. T. Mellor in a paper on "The Upper Witwatersrand System," read before the Geological Society of South Africa.

Mining methods in the district were described by H. Stuart Martin and W. L. Honnold. The paper of the former was published in the *Journal* of the South African Institution of Engineers, March, 1915. In it the author described the general layout of the Modderfontein B. Gold Mines and made particular reference to the methods adopted for the transport of ore underground. The layout of this mine was designed with a view to introducing several features associated with longwall coal mining. W. L. Honnold's paper, "Mining Conditions on the Witwatersrand," appeared in the *Bulletin* of the American Institute of Mining Engineers, August, 1915. It was devoted chiefly to a description of the underground operations at the Brakpan and Springs mines.

"The Centrifugal Pumping Plant of the Durban Roodepoort Deep, Limited," was the title of a paper contributed by E. G. Izod and A. P. Rouillard to the January issue of the *Journal* of the South African Institution of Engineers. The authors expressed satisfaction, after a year's trial, with centrifugal pumps, and stated the reasons that had led to the installation of this type of pump instead of the reciprocating type.

The method of recovering the Bantjes incline shaft was described by Percy Cazalet and W. W. Lawrie, in a paper read before the South African Institution of Engineers and published in the institution's *Journal* for September. The operation, it was said, was probably unique in the experience of the Rand. Standard methods of "spiling" were departed from and a system followed that was an application and modification of the "advancing-shield" method of tunneling in soft and running ground.

Diamonds and Base Metals

The diamond mines remained closed, but it was decided to resume work on a limited scale on Jan. 1, 1916. There was no expansion in the output of base metals. During the eight months to the end of August 2,280 tons of tin were produced and 9,529 tons of copper, as against 2,715 tons and 9.593 tons respectively for the corresponding period of 1914.

The latest tin producer was the Mutue Fides property (in the Waterberg District) of the Transvaal Consolidated Land and Exploration Co., Ltd. The initial output, for May, was 10 tons, but the output was afterwards increased to 15 tons a month. The plant is expected eventually to produce 30 to 40 tons a month. The Marico Zinc Mines, controlled by the same company, had to close down owing to the difficulty of obtaining a reasonable price for the concentrates in spite of the high price of spelter.

Mining in the Russian Empire, 1915

By John Power Hutchins*

The last year was one of difficulty on account of war, and there has been a general decrease in output of nearly all metals and minerals. The particular reasons were the scarcity of mining labor and supplies, high prices for both and an insufficiency of transportation facilities. Transportation was hindered by the large number of freight cars and other railway equipment used for military and naval purposes. Not only did this interfere seriously with the local shipment of mine necessities and products, but it made it difficult to get machinery and supplies from abroad. The mobilization of industrial plants for the production of military and naval supplies and the greater profits accruing to the manufacture of them resulted in some cases in the mine machine and repair shops being used for the manufacture of munitions, with a consequent diminution of the production of metals and minerals.

The shortage of labor, due to mobilization, was a serious obstacle, and in some mines 50% of the total of labor was taken. Some of the mines that contribute largely to the copper production of the Caucasus region were held for a time by the Turks, and the labor of the district—largely Turkish—departed when the Russians reoccupied the district. Some of these mines have been able to operate again, but there has been the need to import labor from other districts, and this has been slow, difficult and costly. Indeed, some of the mines have succeeded in getting only about half as many laborers as needed by paying double normal wages, and others did not even attempt to get a new crew, since the difficulties seemed too great in spite of the high price of copper—about twice that of antebellum times.

Practically all producers of metals and minerals except those that have oil wells have been greatly hindered in transporting their products to market. As tank cars are not used in any considerable number in the transport of war materials, there has not been a shortage of oil cars, but there has been the obstacle of too few locomotives and similar drawbacks.

Most of the zinc and lead mines are in territory that was, immediately after hostilities began, overrun by war movements, and as a result there has been a much-decreased production. It has been extremely difficult to get data as to production of 1914 and 1915, and there will be unusual delays in the issue of official reports. It appears that records of production and consumption of

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some metals and minerals are not being kept, or at least they are not being published. All of the figures of production for 1915 and many of those for 1914 are estimates based upon inquiries among producers. They are therefore unofficial.

Statistics of Gold Production and Development

The production of gold in 1914 was estimated to be worth about $27,000,000. There are no records available for 1915, but it is estimated that there will not be a great difference—probably a slight decline. Many of the one-man operations have been stopped, and while no large producer has had a much reduced output, the total will almost surely be less than for 1914. One of the largest producers, the Lenskoe Co., operating in the Lena River region, will produce about $10,000,000 worth of gold, or about 30% more than in 1914. This, however, will probably not compensate for decreased output due to the interruption of small operations. The Lenskoe mines nearly all its gold by drifting under the floors of present valleys at a depth of about 70 to 125 ft. from the surface. Because of bad methods and management, the total costs of mining are about $10 per cu.yd., with labor at $1 per day and supplies proportionately cheap. Such cost is, of course, unpardonable. One mile of valley has in the past produced about $55,000,000 worth of gold, or over $10,000 per linear foot, which is a record.

There were no important discoveries of new gold fields in 1914 and 1915, although search has been stimulated by the strong demand for gold and the development of some successful quartz mines in the valley of the Yenisei River. The present gold fields are being exhausted, and it is probable that the next few years will witness a continual decline unless some unforeseen stimulus shall come as a result of the war.

Gold Dredging and Hydraulicking

Dredging for gold has had its customary precarious year and has only confirmed the fact that, generally speaking, the Russian Empire is a poor place for gold dredging. Prospecting in the Lena region has given renewed hope that, where such wonderfully rich drifting had been done, there may still be something left to be worked by dredging. Recent results are said to indicate the existence of considerable ground, perhaps 100,000,000 cu.yd. or more, under dredgable conditions.

Modified hydraulicking was tried in 1915. Material was hydraulicked to a chain of buckets which lifted it to such height as to give grade for sluice and dump for tailings. This system, which has never been a success anywhere in the world has, seemingly, failed again.

Straight hydraulicking is done in a few places, but only on a small scale. Auriferous high old channels do not exist, and terrace gravels generally exist where topographic conditions are unfavorable. The Russian Empire, speaking generally, has gentle topographic conditions. Thus the Perm railway between Cheliabinsk and Perm meanders three times from the east to the west watershed of the Ural mountains. However, there are bench gravels in considerable volume in the Altai Mountains under ideal physical hydraulicking conditions. It is possible that investigation will show enough gold in them to pay. About 95% of all the gold produced comes from placers.

The Russian government is attempting to increase the output of gold. Thus it is lending money to the owners of gold mines needing capital for equipment or development. It is probable that this policy will not have a good effect and that many of the loans will never be repaid. The price of gold is now 30% above normal, which about corresponds to the depreciation of the ruble in English exchange.

Platinum Production and Its Prospects

The production of platinum in 1913 was about 381 poods, in 1914 about 157 and in 1915 about 100. The prohibition of the export of platinum, decided after the war began, had the immediate effect of curtailing production. The second half of 1914 and the first half of 1915 were dull, with prices about 30% lower than normal, but recently there has been an upward movement, and prices are now over 53,000 rubles per pood, or about 13 rubles per zolotnik, or $53 per oz. There are severe restrictions against export at present to prevent it being used by Russia's enemies.

Dredges, working platiniferous ground, have had prosperous times. Much ground that could not be worked profitably by hand 10 years ago, when platinum's price was about one-eighth the present quotation, is now extremely profitable. Most of the dredges are of poor design and construction. There is but one American dredge in the Urals, and some mistakes of design, due to inexperience of the local engineers, resulted in getting a lack of correlation of capacities and a hull too small, which results in constant danger of capsizing or sinking.

PRICE OF PLATINUM IN RECENT YEARS

Year	Production in Ounces	Rubles per Ounce 83% Platinum
1909	259,318	46
1910	272,468	49
1911	220,920	70
1912	221,972	72
1913	200,406	71
1914	82,572	70

THE OLDER PRICES FOR 83% PLATINUM

Year	Rubles per Ounce	Year	Rubles per Ounce
1880	5.75	1907	38.00
1900	28.50	1908	31.00
1905	42.00		

There has been produced in the last 15 years about 2,106,400 ounces. There is a renewed effort to make refining and export of platinum a government monopoly. As about 95% of the world's production comes from Russia, such restriction would have a marked effect upon prices. There have been no new discoveries or important developments of platiniferous ground, although there has been an intensive search covering 10 years in the Ural mountains. It is reported that platinum has been discovered near the Mongolian frontier on the watershed of the Yenisei River, but it is not known whether these deposits have commercial value. The matrix has been found to be dunite, and prospecting has resolved itself into, first, a geological search for dunite, and second the determination of the existence of platinum in the alluvium that has accumulated in the stream beds adjacent to the dunite. It is reported that platinum has also been discovered on the Viluee River, a tributary of the Lena.

The Situation in Copper, Coal and Iron

The production of copper in 1913 was 34,000 tons; in 1914, 20,000 tons, and in 1915, about 16,000 tons. This reduction is largely caused by the proximity of the copper mines in the Caucasus, which normally produce 25% of the total amount, to the seat of war. Many of the mines had so many of their men mobilized as to seriously

interfere with output. In several instances about 40% of the labor was taken.

No new or important developments of copper ore were made in 1915, although the big prices, about twice the normal, stimulated prospecting. The extreme difficulty of getting mining or smelting machinery from abroad and the difficulties of transportation will probably hamper copper mining in Russia for some time.

In 1914 about 13,000 tons of copper was imported—9,400 tons through Archangel and 3,600 through Vladivostok. Practically all the copper arriving through Vladivostok came from Japan; 1914 was the first year during which copper came to Russia from Japan. In 1915 there was about twice as much imported from Japan as in 1914.

Coal and iron have been harder hit by the war than any mineral product except manganese. The shortage of labor and cars has been a serious drawback. Numerous collieries have, for a considerable time, received only about 20% of their car requirements. Statistics of production are lacking, but there has been a notable decrease in the output.

In the first quarter of 1915 nearly 500,000 tons of coal was brought to Petrograd from the Don River region. Normally the Petrograd market is supplied by English coal. Wood, which is still burned in large proportion in Petrograd and which normally costs about $8 per cord, now costs more than twice as much. Coal costs in Petrograd at present are about 72 rubles per ton.

The principal deposits of manganese are situated in the Caucasus, about 110 mi. from the Black Sea, and practically all the product, which was normally about 1,000,000 tons per year, was exported through the Dardanelles. Production has been reduced to perhaps 5 to 10% of normal. This industry has suffered more than any other.

The Chiatoori deposits, from which the manganese comes, are well situated for cheap production and export. There is estimated to be about 100,000,000 tons in the field. Mining is done in a crude, wasteful and expensive way on a small scale. There is room for considerable improvement in mining, milling and transport.

The Situation in Zinc, Lead and Oil

Most of the zinc and lead mines are situated in Poland and have not been operated since the outbreak of war. Practically all zinc and lead now used are imported.

The production of oil has increased. In 1914 it was about 510,000,000 poods; in 1915 it was estimated at about 565,000,000 poods. There has been a strong demand for oil as a result of the lack of the usual competition from coal, and the circumstance that tank cars have not been mobilized, except in small number, has helped.

Workmen have been scarce, and wages are high and will probably continue at an abnormal scale. It is thought that the discipline of military service will have a beneficial result upon the efficiency of the Russian laborer. The prohibition of the sale of vodka is having an excellent effect, and an improvement in the efficiency of mine labor is already noticed. It is said that in some regions the output per man has increased 30 to 40% since the outbreak of the war and solely because of the lack of vodka. All employers of mining labor are unanimous in hoping that prohibition will continue.

With prohibition has also come increased thrift, cleanliness and a desire for education. Since the sole pleasure, that of getting drunk, has been put out of reach, the laborer is looking to amusement by reading as a possibility. There is a marked increase in the desire for education. Education is what Russia lacks most, for it is this condition that causes inefficiency. The Russian peasant is much like any other peasant in spite of pseudo-psychological analyses by partly informed travelers who imagine there is a generic reason for his backwardness. When he shall be taught, he will be as good a laborer as any.

The regulations restricting the employment of yellow laborers in the Russian Empire have been removed. For several years there has been a constantly increasing application of laws to prevent using Chinese, Japanese and Korean laborers, especially in Eastern Siberia, where the higher wages have attracted thousands of Mongolians from their overcrowded environments. Yellow labor has not been an unqualified success, and industrious coolies seem to have become lazy through contact with the Russian peasants. One does not find the efficient Chinaman met in the mines in California. It is probable that the influx of several million Mongolians into Siberia would hasten the development of a very rich country needing labor badly.

Most of the sulphuric acid is made from pyrite mined in the Ural Mountains. Much of it contains enough copper to be of considerable importance. There is a strong demand for acid at present, and the price is more than twice that of normal times. There are several new plants being installed with government guarantees, so as to secure the sale of product for several years. As yet there are no sulphuric-acid plants in Siberia. This is an eloquent commentary upon the backwardness of the arts, for there is pyrite and good coal there.

Mining in Australasia in 1915

By W. P. Geary*

The record of the mineral industry in Australasia during 1915, in so far as regards the extent to which operations have been affected by the closing of the metal market as a result of the paralyzing effect of the war, varies little from that of the previous year. Owing to there being no market for the metals, many of the mines closed down or worked on the half-time system for the time being, but toward the close of the year the higher prices ruling for the various industrial metals gave a stimulus to operations generally. However, a close study of the position emphasizes the magnitude of the operations conducted under such disadvantageous circumstances, and also emphasizes the possibilities of the mineral resources of this country under favorable conditions.

The gold production of Australasia has for the past few years declined steadily, and although the falling off

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during 1915 is not so pronounced as in former years, a decline of 176,000 fine oz. is the forecast from the production of 1914.

The following comparative statement shows the yield for the last two years, the figures for 1915 being estimated on the basis of the production for 10 months of that year:

AUSTRALASIAN GOLD YIELD

	1914, Fine Oz.	1915, Fine Oz.
Western Australia	1,232,977	1,234,224
Victoria	413,218	331,297
Queensland	249,468	254,120
New South Wales	124,507	133,723
Tasmania	26,243	16,256
South Australia	6,258	5,500
Northern Territory	2,532	2,500
Commonwealth	2,055,203	1,977,620
New Zealand	210,787	113,746
Total	2,265,990	2,091,366

Western Australia, as usual, has contributed the largest yield and is followed by Victoria, Queensland and New South Wales in the order named. At the Edna May mine, Western Australia, during the half-year ended Apr. 30, 1915, 17,257 tons was treated for a yield of 15,829 oz. gold from the battery. In addition, 14,900 tons of sands yielded 3,809 oz. The value of the reserves in sight is estimated at $1,315,000, and it is confidently expected that the mine will open up profitably at the deeper levels.

The ore reserves at the Great Boulder, Great Fingall and Bullfinch Proprietary at Dec. 31, 1914, were estimated at 560,647 tons, value 14.85 dwt.; 63,360 tons, average value 35s. per ton; and 101,402 tons of an assay of 27.55s.

The industry in Victoria cannot be viewed with satisfaction, as the yield of gold for 1915 promises to be much below that recorded for the previous year. A notable shrinkage is shown in the production of gold from the Bendigo field for the first six months, which amounted to 58,582 oz., as against 88,263 oz. for the same period last year. The prospects for the current half-year are considered to be more favorable, as many of the mines that suspended operations on account of the drought have resumed work.

In Queensland the output gives every indication of exceeding that for the preceding year. The total revenue of the Mount Morgan Co. for the year ended May 30, 1915, was $5,026,995. The ore reserves at the end of May, 1915, were stated to be 1,060,637 tons of high grade and 1,786,560 tons of medium grade. The production for the period mentioned was 9,075 tons of copper and 116,505 oz. gold.

In New South Wales there were no developments worthy of note during the year. The yield has been mainly furnished by the established mines on the Cobar and Wylong fields and by the dredging plants.

The Copper Production of 1915

It may be expected that the Australian production of copper for 1915 will approximate 35,000 tons. This, compared with the previous year, shows an increase of about 1,000 tons, which in turn is 9,000 tons less than the output for 1913, the last year that was not influenced by war conditions. Roughly, the drop may be ascribed to the partial cessation of operations at the Great Cobar mine, which for some years was one of the leading copper producers of the commonwealth.

The output of New South Wales is usually from 9,000 to 10,000 tons per annum. Owing to the partial closing down of the Cobar mine the production this year may not account for much more than 1,000 tons. There are many lodes of promise, but as they are remote from railways they cannot be profitably worked under present circumstances.

Queensland has been more fortunate in respect to its railway facilities to mining centers, and as a result has rapidly progressed in copper production. Queensland produces more than 50% of the total output of the commonwealth and for 1915 turned out approximately 19,000 tons of copper. This was drawn chiefly from the Cloncurry district, which includes such mines as Hampdem, Mount Elliot and Mount Cuthbert. The Mount Morgan mine is now generally known as a copper producer, after having in the past contributed several million pounds' worth of gold.

South Australia accounted for approximately 6,500 tons of copper, of which just about 99% will be drawn from the Wallaroo & Moonta property. These old established mines are still prosperous, although in many respects operations are conducted on exceedingly conservative lines.

The Tasmanian output approximated 7,350 tons, of which 7,000 tons was credited to Mount Lyell. This company has latterly been able to reduce its costs somewhat by the installation of water power, and in addition has been fortunate in the lower levels in opening up a large quantity of high-grade ore. The Mount Lyell company is a factor in the superphosphate industry. The pyritic ores from the Mount Lyell and Chester mines furnish considerable of the sulphur necessary for acid making.

The Western Australian production is small and may be set down at 750 tons, the bulk of which came from the mines and smeltery which are being worked by the state government at Ravensthorpe. Papua holds a number of exceedingly promising copper propositions. One in particular, the Laloki, has been subject to extensive development, and the ore reserves are set down at some hundreds of thousands of tons of 4% pyritic ore. Railway facilities, however, are essential before the mine can be worked on a commercial scale.

Output of Silver, Lead and Zinc

War conditions resulted in a serious curtailment of operations on the Broken Hill field, New South Wales, and this is reflected in the exports of silver-lead products which show a comparative decrease of $3,369,060 for the nine months ending in September. The value of the zinc concentrates shows a decrease of $1,146,775 for the same period. During the six months ended May 31, the Broken Hill Proprietary Co. raised 109,911 tons of ore at Broken Hill as compared with 121,316 tons for the previous half year. The production of lead concentrates was 17,900 tons, as compared with 20,060 tons for the preceding half-year. At the close of the term, the Port Pirie works were handed over to the new company, the Broken Hill Associated Smelters, the Proprietary company receiving for its interest $1,500,000 cash and 150,000 fully paid shares, with an additional 50,000 fully paid shares for stocks taken over. The Broken Hill South Co. raised 131,059 tons of sulphide ore of an average value of 14.9% lead, 7.5 oz. silver and 14.7% zinc, for the half-year ended June 30. For the same period the North Broken Hill Co. produced 24,430 tons of con-

centrates from 123,455 tons of ore treated of an average assay of 61.9% lead, 21.1 oz. silver and 8.8% zinc.

In Queensland a satisfactory increase is recorded in the output of silver, but the production of lead is 67 tons less than that obtained during the corresponding first nine months of 1914. In Tasmania the output from the mines at Zeehan and other districts has been greatly restricted owing to the closing down of many of the silver-lead mines on the west coast. Unfortunately exploratory work as carried out during the past few years has proved with few exceptions unproductive; consequently no new orebodies have been discovered to take the place of the depleted ore reserves.

Th exportation of 50,000 tons of zinc concentrates by the Amalgamated Zinc (De Bavay's) Co., Broken Hill, has been approved by the attorney general. The imperial authorities have offered no objection to the shipment of the quantity mentioned, which was lately sold in America.

The Year's Tin Production

The Mount Bischoff tin mine, Tasmania, produced 55,076 tons during the first half of the year, of which 52,187 tons was delivered to the mills for a yield of 238 tons of concentrates. The ore reserves are estimated at 1,720,000 tons, the northern slopes and northern valley accounting for 850,000 tons, and the eastern and western slopes for 540,000 tons. The smelting works at Launceston treated 1,241 tons concentrates, of which 1,014 tons was on behalf of other companies. The total yield amounted to 856 tons of tin.

During the year ended June 30, 1915, the Pioneer Tin Mining Co., Tasmania, obtained 327 tons of stream tin from 613,700 cu.yd. of wash, as against 441 tons from 571,700 yd. in 1914. The total production from the Pioneer mine from 1900 to 1915 is given as 5,530 tons from 6,786,200 cu.yd., the average value of the wash being 1.825 lb. per yd. The exceptionally dry weather experienced and the closing of the metal market on account of the war seriously interfered with sluicing operations.

In New South Wales, the deposits in the Tingha and Emmaville districts continue to be systematically worked. The operations of the dredges, although handicapped to some extent by the scarcity of water, continued.

On the Ardlethan tin field work at the various mines is being vigorously proceeded with, and it is expected that the production will be much in advance of that recorded for the previous year. The exports of tin from this state during the first nine months of the year were valued at $972,420, or $294,430 below that for the same term in 1914.

In Queensland the output shows a substantial increase on that of the preceding year, the production to the end of September totaling 1,520 tons, valued at $649,160. In the Herberton district the drought had a bad effect on the mining operations. At the Vulcan mine, in November, payable ore was being driven in on the 720-ft. level. It was stated that the 600-ft. stope had improved in area and that 5% ore was being broken on a face averaging 11x8 ft. During the month 850 tons of ore was crushed for a production of 22 tons of first concentrate valued at $7,130. For the nine months ended with September, tin to the value of £24,050 was produced in the state of Western Australia.

In connection with the production and disposal of molybdenite, wolframite and scheelite, the commonwealth government has entered into an arrangement with the imperial government for 12 months to acquire for the imperial government all molybdenite, wolframite and scheelite produced in Australia. The price fixed for the minerals delivered c.i.f. London is as follows:

GOVERNMENT PRICES FOR MINERALS

Molybdenite	105 shillings per unit of MoS_2	(molybdenum sulphide)
Wolframite	55 shillings per unit of WO_3	(tungsten tri-oxide)
Scheelite	55 shillings per unit of WO_3	

The grade has been fixed by the imperial authorities at a minimum of 90% MoS_2 for molybdenite and at least 65% WO_3 for wolframite or scheelite. Impurities are not to exceed 0.5% of tin and 0.5% of bismuth.

In Queensland the quantity and value of tungsten produced to the end of September was 199 tons, valued at $121,535; bismuth-tungsten, 227 tons, valued at $100,-325; and molybdenite, 69 tons, valued at $165,000.

At Torrington in New South Wales, good ore is being produced at various tungsten mines.

At the molybdenite mines at Glen Innes and Pambula (Whipstick) operations were continuously carried on, and the output of ore has been well maintained.

In connection with iron smelting, it may be stated that in addition to the Eskbank Iron Works at Lithgow, N. S. W., the Broken Hill Proprietary Co. established large iron and steel works at Waratah, on Newcastle Harbor, N. S. W., during the year at a cost of about $7,500,000. This is a work of national importance, enabling Australia to supply from her own products the iron and steel that are required not only in railroad construction, but for locomotives, shipbuilding, etc. The iron ore used at the new works is obtained from Iron Knob, S. A., whence it is railed to Port Pirie and thence shipped to Newcastle. This ore yields on an average 68% of metallic iron.

Ore Production of United States

The following table by the United States Geological Survey shows the production of crude ores supplied from domestic mines to gold and silver mills, concentrating plants, and smelters:

PRODUCTION OF CRUDE ORES FROM DOMESTIC MINES 1911-14
IN SHORT TONS

	1911	1912	1913	1914
Iron ores (marketed production)	46,023,540	63,859,728	66,800,270	44,479,994
Manganese ore	2,752	1,864	4,534	2,951
Manganiferous iron ore	3,006	3,247	10,808	65,390
Chromic iron ore	134	225	286	662
Tungsten ore	16,500	34,000	34,400	17,800
Titanium ore	.....	6,900	7,600	2,350
Aluminum ore	174,292	179,049	235,470	245,636
Gold ore	9,884,684	9,736,203	9,403,622	9,669,254
Silver ore	739,200	848,574	1,253,116	1,297,412
Quicksilver ore	138,525	155,693	136,278	122,998
Tin ore	42,200	3,000	7,500	16,600
Vanadium and uranium ore	8,468	18,000	27,900	*24,500
Antimony ore	.....	.....	116	60
Copper ore:				
Western States	18,207,566	23,431,301	28,427,543	27,653,352
Central States	10,978,827	11,411,941	7,016,831	9,269,465
Eastern States	801,842	830,089	892,308	907,894
Total	29,988,235	35,673,331	36,336,682	37,830,711
Copper-lead ore	6,923	14,614	24,399	11,577
Lead ore:				
Western States	2,157,817	2,388,598	2,563,904	2,307,550
Central States	3,794,712	4,064,366	4,250,800	4,718,300
Total	5,952,529	6,452,964	6,814,704	7,025,850
Zinc and zinc-lead ore:				
Western States	1,356,781	1,344,222	1,658,486	2,117,558
Central States	10,629,269	11,899,185	10,767,340	9,747,210
Eastern States	413,332	497,832	692,348	901,184
Total	12,399,382	13,741,239	13,118,174	12,765,952
Grand total	105,380,370	130,728,622	134,215,858	113,579,697

*Estimated.